In This Section

- Sources and Types of Environmental Stressors
- Summary of Stressors Affecting Water Quality

Section 4

Water Quality: Environmental Stressors

Sections 4, 5, 6, and 7 are closely linked, providing the foundation for the water quality concerns in the basin, identifying the priority issues based on these concerns, and finally, recommending management strategies to address these concerns. Therefore, the reader will probably want to flip back and forth between sections to track specific issues.

This section describes the important environmental stressors that impair or threaten water quality in the Savannah River basin. Section 4.1 first discusses the major sources of environmental stressors. Section 4.2 then provides a summary of individual stressor types as they relate to all sources. These include both traditional chemical stressors, such as metals or oxygen demanding waste, and less traditional stressors, such as modification of the flow regime (hydromodification) and alteration of physical habitat.

4.1 Sources and Types of Environmental Stressors

This section describes the major potential sources of environmental stressors within the Savannah River basin. These sources include point source discharges, nonpoint source contributions from land-use activities, and temperature and flow modifications. The sources are discussed by type, which provides a match to regulatory lines of authority for permitting and management.

4.1.1 Point Sources and Non-discharging Waste Disposal Facilities

Point sources are defined as discharges of treated wastewater to the river and its tributaries, regulated under the National Pollutant Discharge Elimination System (NPDES). These are divided into two main types–permitted wastewater discharges, which tend to be discharged at relatively stable rates, and permitted storm water discharges, which tend to be discharged at highly irregular, intermittent rates, depending on precipitation. Nondischarging waste disposal facilities, including land application systems and landfills, which are not intended to discharge treated effluent to surface waters, are also discussed in this section.

NPDES Permitted Wastewater Discharges

The EPD NPDES permit program regulates municipal and industrial waste discharges, monitors compliance with limitations, and takes appropriate enforcement action for violations. For point source discharges, the permit establishes specific effluent limitations and specifies compliance schedules that must be met by the discharger. Effluent limitations are designed to achieve water quality standards in the receiving water and are reevaluated periodically (at least every 5 years).

Municipal Wastewater Treatment Plant Discharges

Municipal wastewater treatment plants are among the most significant point sources regulated under the NPDES program in the Savannah River basin, accounting for the majority of the total point source effluent flow (exclusive of cooling water). These plants collect, treat, and release large volumes of treated wastewater. Pollutants associated with treated wastewater include pathogens, nutrients, oxygen-demanding waste, metals, and chlorine residuals. Over the past several decades, Georgia has invested more than $136 million in construction and upgrade of municipal water pollution control plants in the Savannah River basin; a summary of these investments is provided in Appendix C. These upgrades have resulted in significant reductions in pollutant loading and consequent improvements in water quality below wastewater treatment plant outfalls. As of the 1998-1999 water quality assessment, 69 miles of river/streams were identified in which municipal discharges contributed to not fully supporting designated uses, all of which are being addressed through the NPDES permitting process.

Table 4-1 lists the major municipal wastewater treatment plants with permitted discharges of 1 million gallons per day (MGD) or greater in the Savannah River basin. The geographic distribution of dischargers is shown in Figure 4-1. In addition, there are discharges from a variety of smaller wastewater treatment plants, including both public facilities (small public water pollution control plants, schools, marinas, etc.) and private facilities (package plants associated with non-sewered developments and mobile home parks) with less than a 1 MGD flow. These minor discharges might have the potential to cause localized stream impacts, but they are relatively insignificant from a basin perspective. A complete list of permitted discharges in the Savannah River Basin is presented in Appendix D.

Most urban wastewater treatment plants also receive industrial process and nonprocess wastewater, which can contain a variety of conventional and toxic pollutants. The control of industrial pollutants in municipal wastewater is addressed through pretreatment programs. The major publicly owned wastewater treatment plants in this basin have developed and implemented approved local industrial pretreatment programs. Through these programs, the wastewater treatment plants are required to establish effluent limitations for their significant industrial dischargers (those which discharge in excess of 25,000 gallons per day of process wastewater or are regulated by a Federal Categorical Standard) and to monitor the industrial user's compliance with those limits. The treatment plants are able to control the discharge of organics and metals into their sewerage system through the controls placed on their industrial users.

Industrial Wastewater Discharges

Industrial and federal wastewater discharges are also significant point sources regulated under the NPDES program. There are a total of 142 permitted municipal, state, federal, private, and industrial wastewater and process water discharges in the Savannah River basin, as summarized in Table 4-2. The complete permit list is summarized in Appendix D.

Table 4-1. Major Municipal Wastewater Treatment Plant Discharges with Permitted Monthly Flow Greater than 1 MGD in the Savannah River Basin

NPDES Permit No.	Facility Name	County	Receiving Stream	Permitted Monthly Avg. Flow (MGD)
HUC 03060102				
GA0021814	Toccoa Eastanollee Cr WPCP	Stephens	Eastanollee Creek	1.450
HUC 03060103				
GA0020885	Hartwell WPCP	Hart	Cedar Creek	1.250
HUC 03060104				
GA0026247	Commerce Northside WPCP	Jackson	Beaver Dam Creek	1.050
GA0047589	Lavonia WPCP	Franklin	Bear Creek	1.320
HUC 03060105				
GA0020974	Thomson WPCP	Mcduffie	Whites Creek	2.500
GA0031101	Washington WPCP	Wilkes	Rocky Creek	4.000
HUC 03060106				
GA0037621	Augusta Butler Creek WPCP	Richmond	Butler Creek	46.100
GA0031984	Columbia Co Crawford WPCP	Columbia	Crawford Creek	1.500
GA0047775	Columbia Co Little River WPCP	Columbia	Savannah River	1.500
GA0031992	Columbia Co Reed WPCP	Columbia	Reed Creek	4.600
GA0047147	Richmond Co Spirit Cr WPCP	Richmond	Spirit Creek	2.240
HUC 03060108				
GA0020231	Waynesboro WPCP	Burke	Mcintosh Creek	2.000
HUC 03060109				
GA0031038	Garden City WPCP	Chatham	Savannah River	2.000
GA0025348	Savannah President St. WPCP	Chatham	Savannah River	27.000
GA0020427	Savannah Travis Field WPCP	Chatham	Savannah River	1.000
GA0020443	Savannah Wilshire/Windsor WPCP	Chatham	Vernon River	4.500
GA0021385	Sylvania WPCP	Screven	Buck Creek	1.510
GA0020061	Tybee Island WPCP	Chatham	Savannah River	1.000

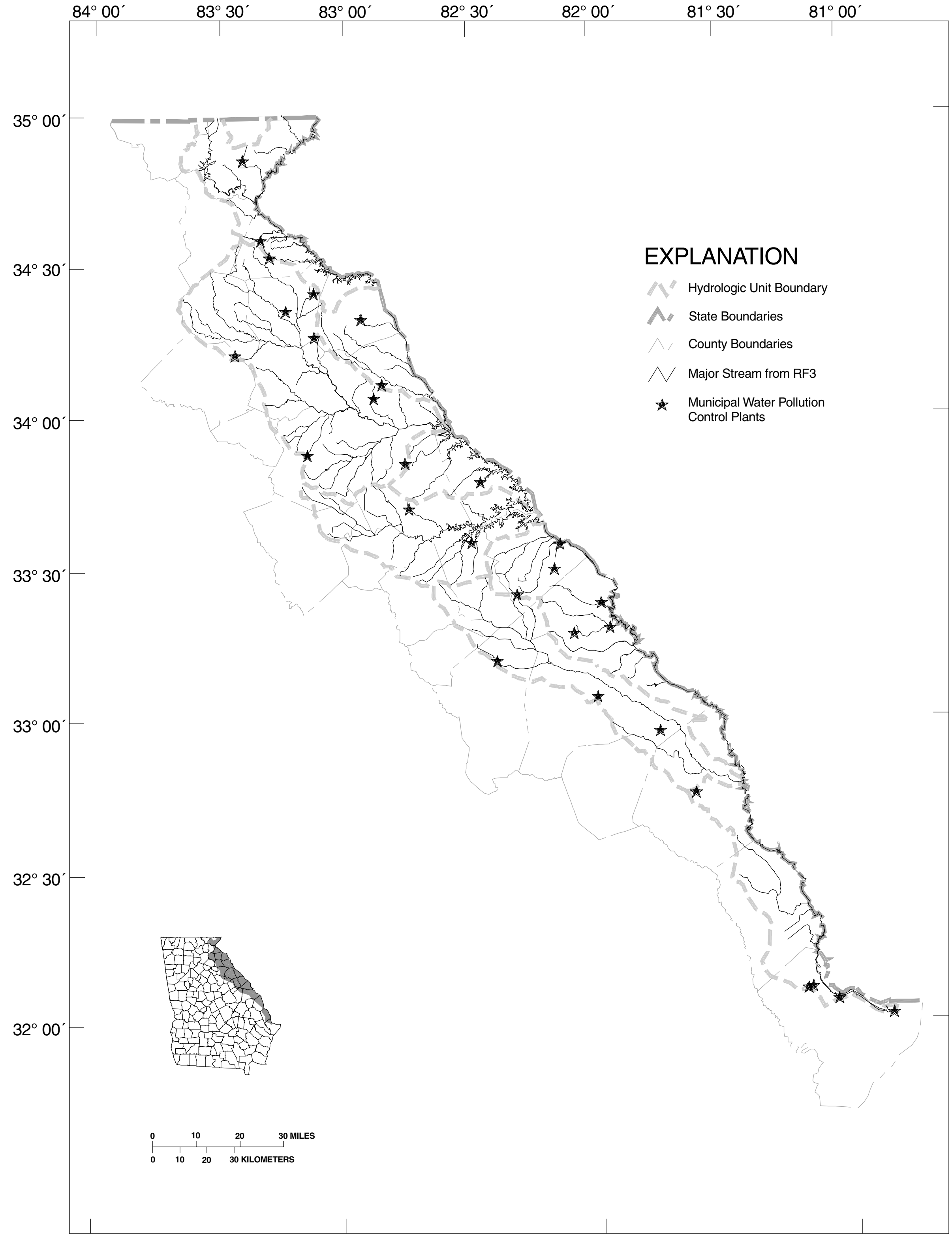

Figure 4-1. Location of Municipal Wastewater Treatment Plants in the Savannah River Basin

Table 4-2. Summary of NPDES Permits in the Savannah River Basin

HUC	Major Municipal Facilities	Major Industrial and Federal Facilities	Minor Public Facilities	Minor Private and Industrial Facilities	Total
03060102	1	1	4	15	21
03060103	1	0	4	7	12
03060104	2	0	13	14	29
03060105	2	0	1	1	4
03060106	5	5	6	12	28
03060108	1	0	2	4	7
03060109	6	7	5	23	41
Total	18	13	35	76	142

The nature of industrial discharges varies widely compared to discharges from municipal plants. Effluent flow is not usually a good measure of the significance of an industrial discharge. Industrial discharges can consist of organic, heavy oxygen-demanding waste loads from facilities such as pulp and paper mills; large quantities of noncontact cooling water from facilities such as power plants; pit pumpout and surface runoff from mining and quarrying operations, where the principal source of pollutants is the land-disturbing activity rather than the addition of any chemicals or organic material; or complex mixtures of organic and inorganic pollutants from chemical manufacturing, textile processing, metal finishing, etc. Pathogens and chlorine residuals are rarely of concern with industrial discharges, but other conventional and toxic pollutants must be addressed on a case-by-case basis through the NPDES permitting process. Georgia's 1998-1999 water quality assessment identified 16 miles of rivers/streams in the basin where permitted industrial discharges contributed to a failure to support designated uses; this is being addressed through the NPDES permitting process. Table 4-3 lists the major industrial and federal wastewater treatment plants with discharges into the Savannah River basin in Georgia.

There are also 58 minor industrial discharges which may have the potential to cause localized stream impacts, but are relatively insignificant from a basin perspective. The locations of permitted point source discharges of treated wastewater in the Savannah River basin are shown in Figures 4-2 through 4-8.

Combined Sewer Overflows

Combined sewers are sewers that carry both storm water runoff and sanitary sewage in the same pipe. Most of these combined sewers were built at the turn of the century and were present in most large cities. At that time both sewage and storm water runoff were piped from the buildings and streets to the small streams that originated in the heart of the city. When these streams were enclosed in pipes, they became today's combined sewer systems. As the cities grew, their combined sewer systems expanded. Often new combined sewers were laid to move the untreated wastewater discharge to the outskirts of the town or to the nearest waterbody.

In later years wastewater treatment facilities were built and smaller sanitary sewers were constructed to carry the sewage (dry weather flows) from the termination of the combined sewers to these facilities for treatment. However, during wet weather, when significant storm water is carried in the combined system, the sanitary sewer capacity is exceeded and a combined sewer overflow (CSO) occurs. The surface discharge is a

Table 4-3. Major Industrial and Federal Wastewater Treatment Facilities in the Savannah River Basin

NPDES Permit No.	Facility Name	County	Description	Flow (MGD)	Receiving Stream
HUC 03060102					
GA0002038	Coats American Inc	Stephens	Textile	2.0	Eastanollee Creek
HUC 03060106					
GA0002071	Arcadian Fertilizer L.p.	Richmond	Fertilizer	1.8	Savannah River
GA0002160	Dsm Chemicals Augusta Inc	Richmond	Chemical-nylon	2.2	Savannah River
GA0026786	Georgia Power Vogtle	Burke	Nuclear Power	7.2	Savannah River
GA0002801	International Paper Company	Richmond	Pulp and Paper	49.0	Savannah River
GA0003484	USA Ft Gordon	Richmond	Sewage	2.1	Butler Cr-Spirit Cr
HUC 03060109					
GA0046973	Fort James Operating Company	Effingham	Pulp and Paper	13.9	Savannah River
GA0003646	Kemira	Chatham	Inorganic Chemicals	24.5	Savannah River
GA0002356	Pcs Nitrogen Fertilizer LP	Chatham	Nitrogen Fertilizers	0.2	Savannah River
GA0003883	Savannah Elec Effingham	Effingham	Steam Electric	108.0	Savannah River
GA0002798	Stone Container Corp	Chatham	Pulp and Paper	38.0	Savannah River
GA0001988	Union Camp Corporation	Chatham	Pulp and Paper	42.3	Savannah River
GA0027588	USA Hunter Afb Stp	Chatham	Sewage	1.25	Forrest River

mixture of storm water and sanitary waste. Uncontrolled CSOs thus discharge raw diluted sewage and can introduce elevated concentrations of bacteria, BOD, and solids into a receiving water body. In some cases, CSOs discharge into relatively small creeks.

CSOs are considered a point source of pollution and are subject to the requirements of the Clean Water Act. Although CSOs are not required to meet secondary treatment effluent limits, sufficient controls are required to protect water quality standards for the designated use of the receiving stream. In its 1990 session, the Georgia Legislature passed a CSO law requiring all Georgia cities to eliminate or treat CSOs.

There are no known combined sewer overflows in the Savannah River Basin. Combined sewer overflows in Augusta were eliminated prior to December 1996 by Augusta-Richmond Utilities Department sewer separation projects.

NPDES Permitted Storm Water Discharges

Urban storm water runoff in the Savannah basin has been identified as a major source of stressors from pollutants such as oxygen-demanding waste (BOD) and fecal coliform bacteria. Storm water may flow directly to streams as a diffuse, nonpoint process, or may be collected and discharged through a storm sewer system. Storm sewers are now subject to NPDES permitting and are discussed in this section. Contributions from nonpoint storm water is discussed in later sections.

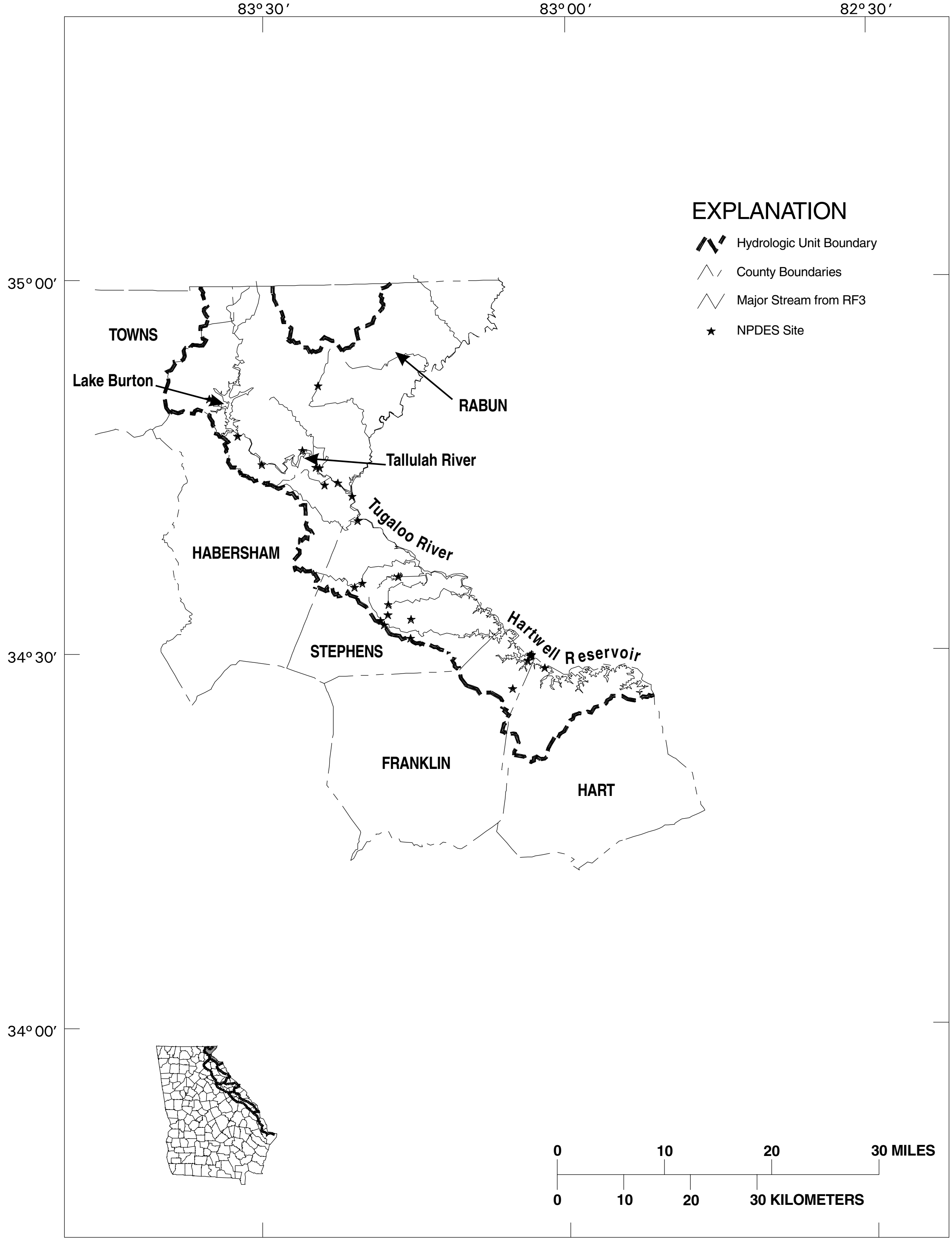

Figure 4-2. NPDES Sites Permitted by GAEPD, Savannah River Basin, HUC 03060102

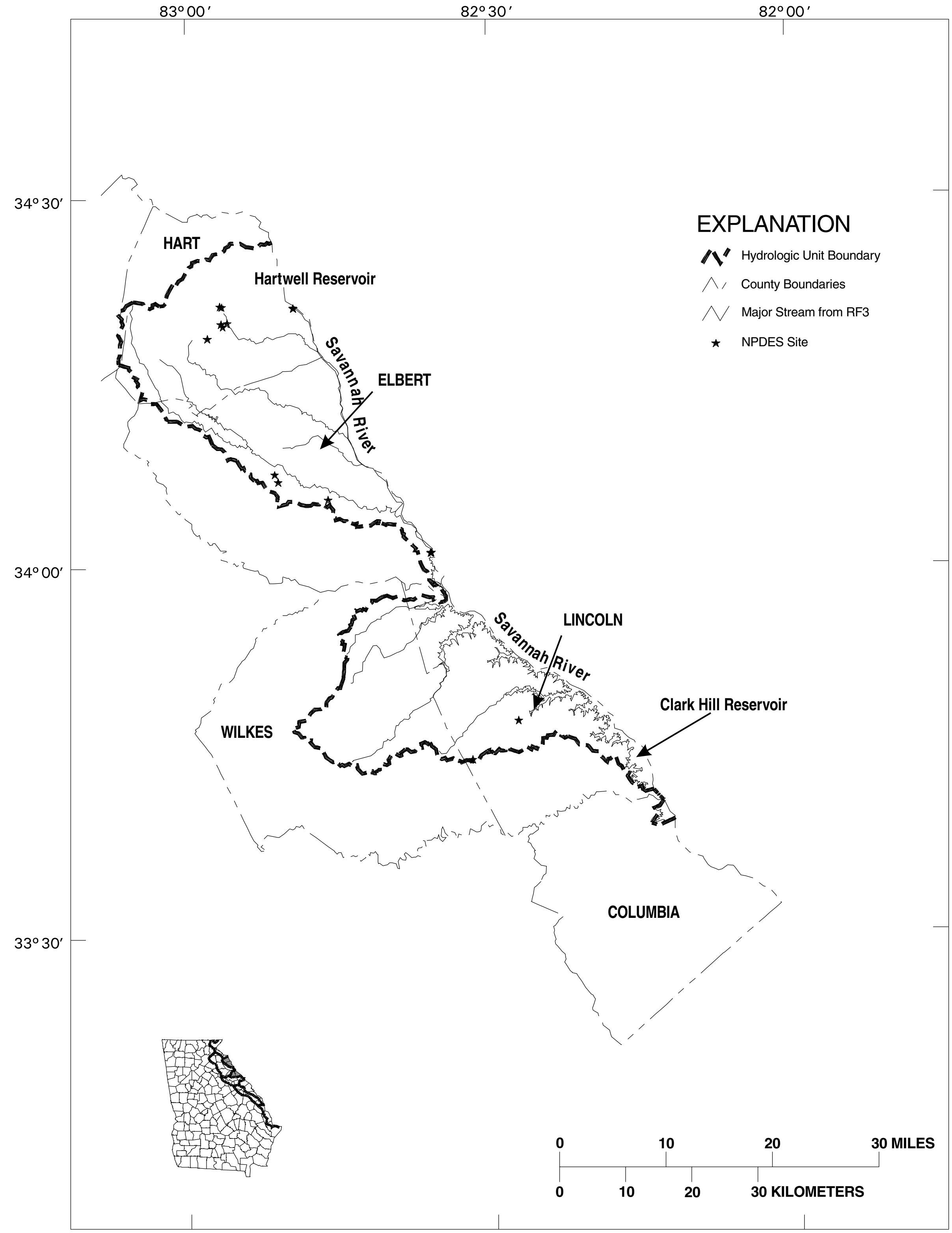

Figure 4-3. NPDES Sites Permitted by GAEPD, Savannah River Basin, HUC 03060103

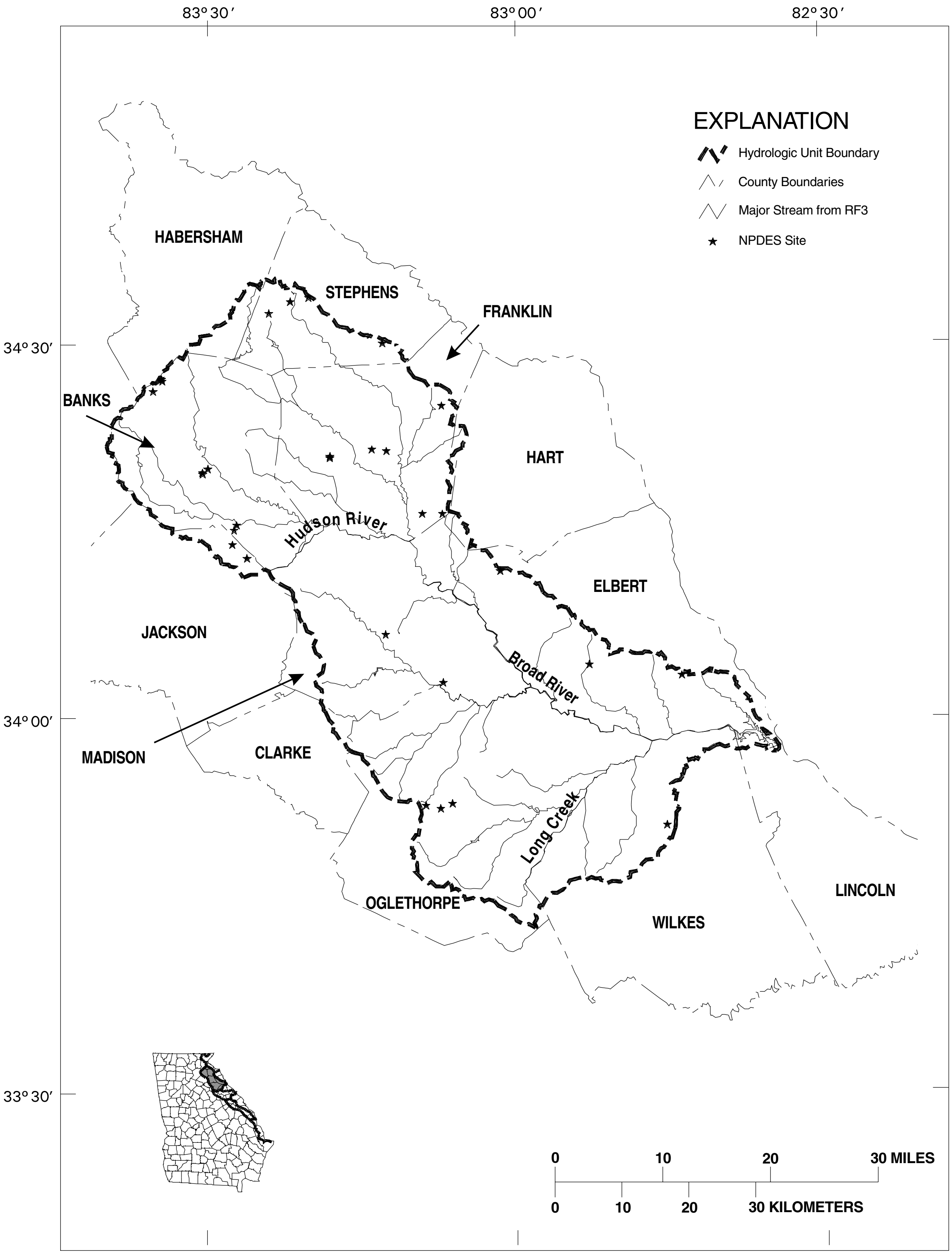

Figure 4-4. NPDES Sites Permitted by GAEPD, Savannah River Basin, HUC 03060104

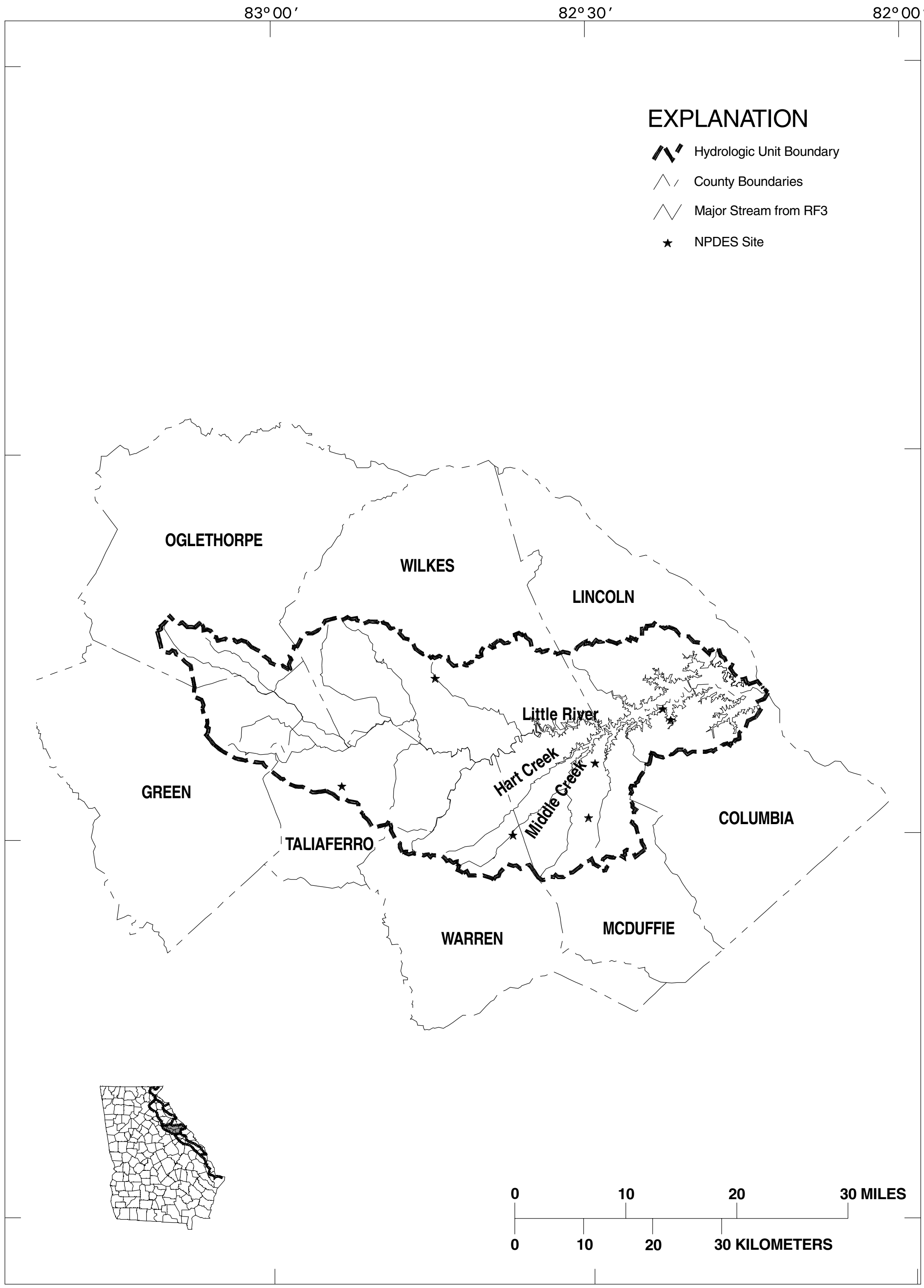

Figure 4-5. NPDES Sites Permitted by GAEPD, Savannah River Basin, HUC 03060105

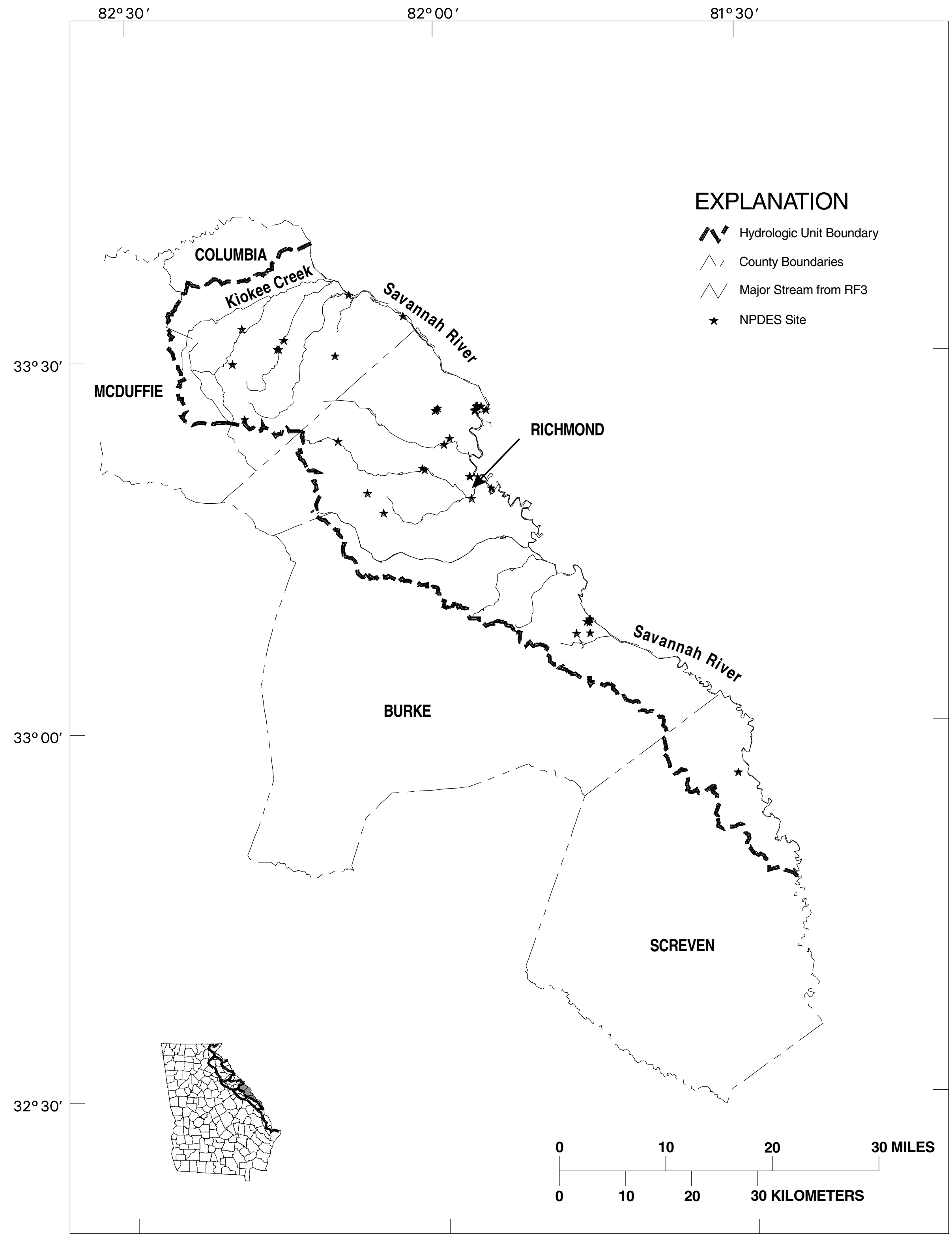

Figure 4-6. NPDES Sites Permitted by GAEPD, Savannah River Basin, HUC 03060106

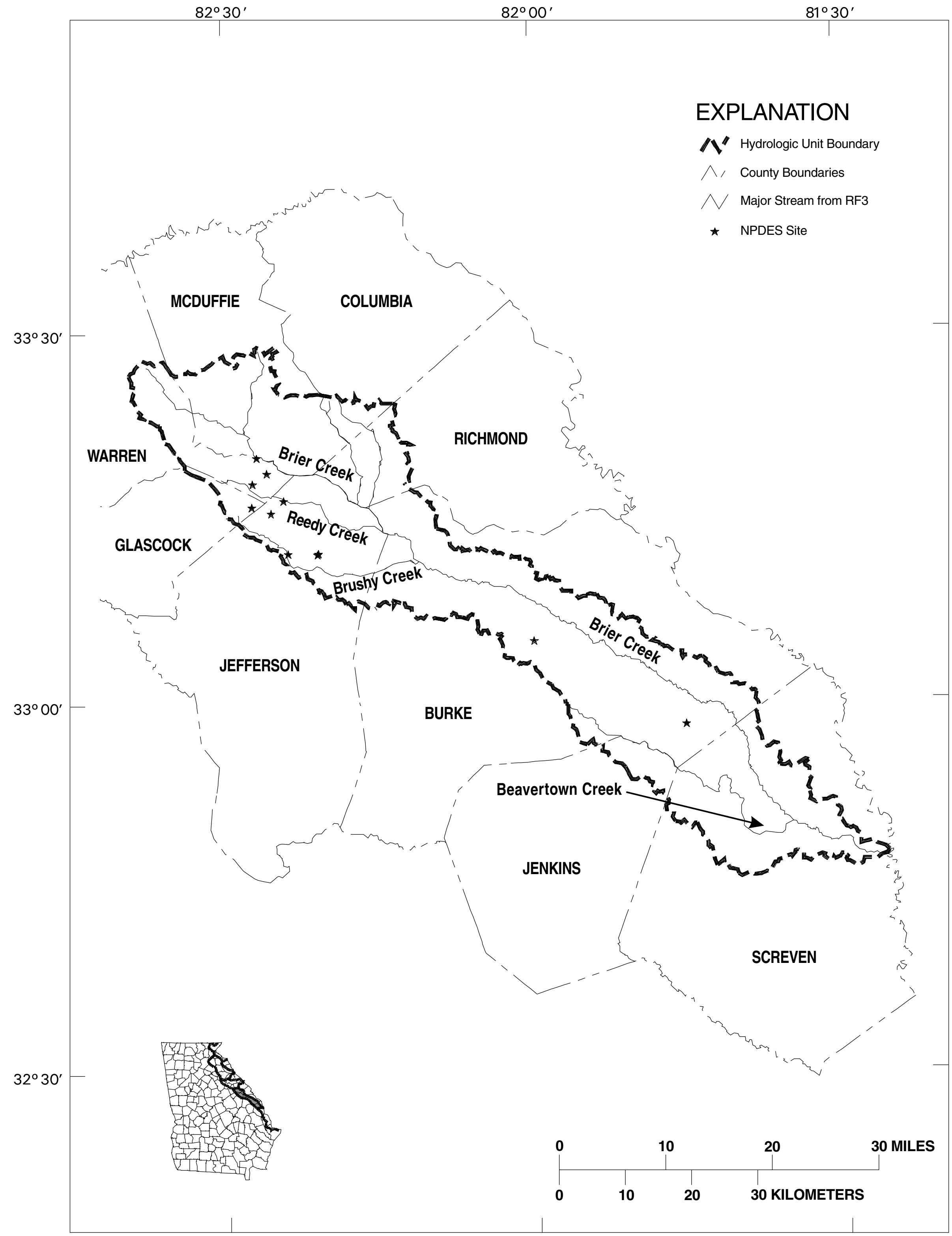

Figure 4-7. NPDES Sites Permitted by GAEPD, Savannah River Basin, HUC 03060108

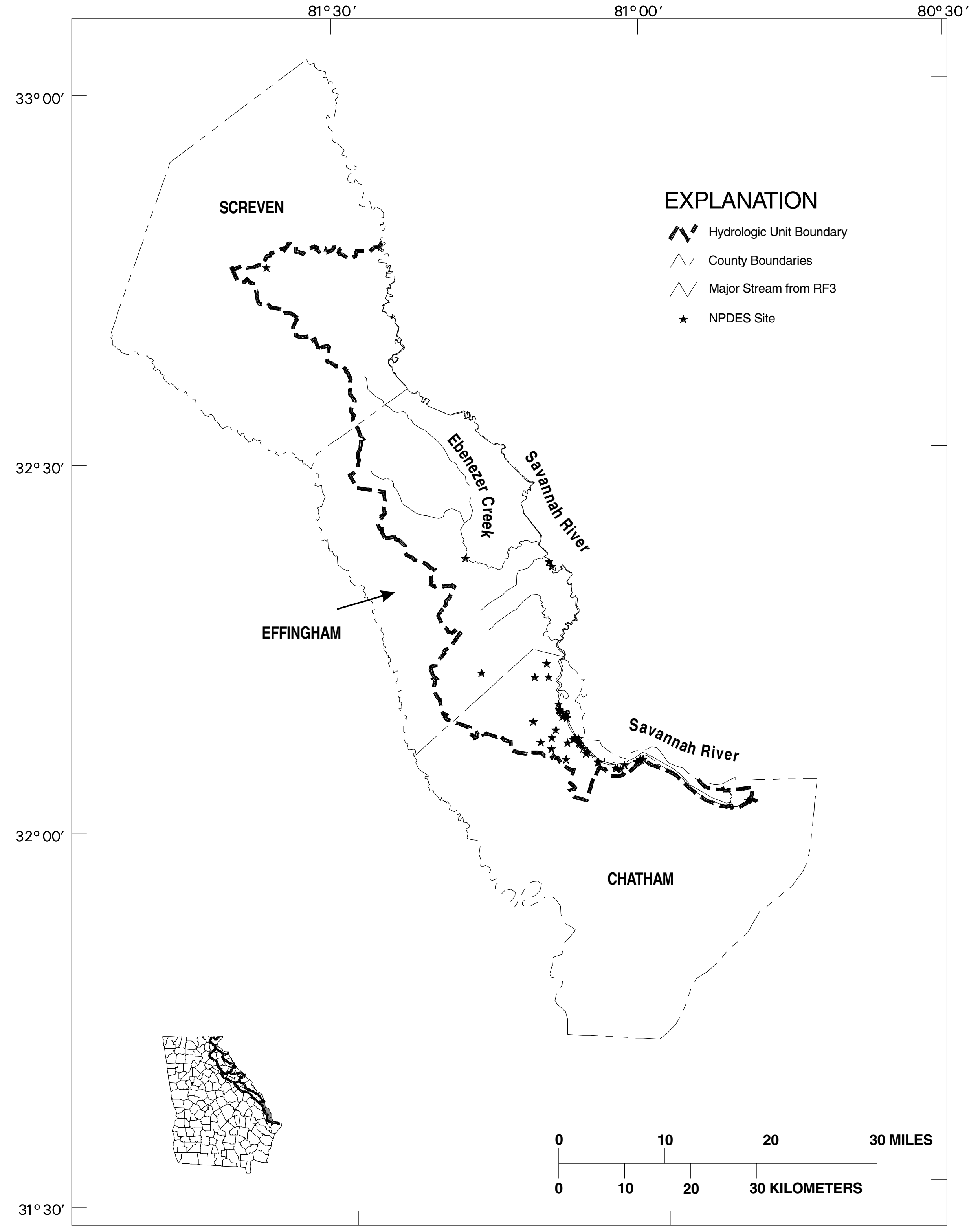

Figure 4-8. NPDES Sites Permitted by GAEPD, Savannah River Basin, HUC 03060109

Pollutants typically found in urban storm water runoff include pathogens (such as bacteria and viruses from human and animal waste), heavy metals, debris, oil and grease, petroleum hydrocarbons and a variety of compounds toxic to aquatic life. In addition, the runoff often contains sediment, excess organic material, fertilizers (particularly nitrogen and phosphorus compounds), herbicides, and pesticides which can upset the natural balance of aquatic life in lakes and streams. Storm water runoff may also increase the temperature of a receiving stream during warm weather, which potentially threatens valuable trout fisheries in the Savannah River basin. All of these pollutants, and many others, influence the quality of storm water runoff. There are also many potential problems related to the quantity of urban runoff, which can contribute to flooding and erosion in the immediate drainage area and downstream.

Municipal Storm Water Discharges

In accordance with Federal “Phase I” storm water regulations, the state of Georgia has issued individual areawide NPDES municipal separate storm sewer system (MS4) permits to 58 cities and counties in municipal areas with populations greater than 100,000 persons. In the Savannah River Basin storm water permits were issued to Augusta and Savannah and the counties surrounding these cities.

Industrial Storm Water Discharges

Industrial sites often have their own storm water conveyance systems. The volume and quality of storm water discharges associated with industrial activity is dependent on a number of factors, such as the industrial activities occurring at the facility, the nature of the precipitation, and the degree of surface imperviousness (hard surfaces). These discharges are of intermittent duration with short-term pollutant loadings that can be high enough to have shock loading effects on the receiving waters. The types of pollutants from industrial facilities are generally similar to those found in storm water discharges from commercial and residential sites; however, industrial facilities have a significant potential for discharging at higher pollutant concentrations, and may include specific types of pollutants associated with a given industrial activity.

EPD has issued has issued NPDES General Permit No. GAR000000 regulating storm water discharges for 10 of 11 federally regulated industrial subcategories. The general permit for industrial activities requires the submission of a Notice of Intent (NOI) for coverage under the general permit; the preparation and implementation of storm water pollution prevention plan; and, in some cases, analytical testing of storm water discharges from the facility. As with the municipal storm water permits, implementation of site-specific best management practices is the preferred method for controlling storm water runoff. As of August 2000, approximately 391 NOIs had been filed for the Savannah River basin. The approximate distribution of NOIs by HUC is as follows:

HUC 03060108 (Brier River Basin)	31
HUC 03060104 (Broad River Basin)	41
HUC 03060105 (Little River Basin)	15
HUC 03060109 (Lower Savannah River Basin)	108
HUC 03060106 (Middle Savannah River Basin)	150
HUC 03060102 (Tugaloo River Basin)	21
HUC 03060103 (Upper Savannah River Basin)	25

The 11th federally regulated industrial subcategory (construction activities) is covered under NPDES General Permit No. GAR100000. This general permit regulates storm water discharges associated with construction activity at sites and common developments disturbing more than five acres. The general permit requires the submission of a Notice of Intent (NOI) to obtain coverage under the permit, the preparation and implementation of an Erosion, Sedimentation, and Pollution Control Plan, and the preparation and implementation of a Comprehensive Monitoring Program which provides for monitoring of turbidity levels in the receiving stream(s) and/or storm water outfalls(s) during certain rain events. The general permit became effective on August 1, 2000 and will expire on July 31, 2003.

Nondischarging Waste Disposal Facilities

Land Application Systems (LASs)

In addition to permits for point source discharges, EPD has developed and implemented a permit system for land application systems (LASs). LASs for final disposal of treated wastewaters have been encouraged in Georgia and are designed to eliminate surface discharges of effluent to waterbodies. LASs are used as an alternative to advanced levels of treatment or as the only alternative in some environmentally sensitive areas.

When properly operated, a LAS should not be a source of stressors to surface waters. The locations of LASs are, however, worth noting because of the (small) possibility that a LAS could malfunction and become a source of stressor loading.

A total of 128 municipal and 35 industrial permits for land application systems were in effect in Georgia in 1998. Municipal and other wastewater land application systems within the Savannah Basin are listed in Table 4-4. The locations of all LASs within the basin are shown in Figures 4-9 through 4-15.

Table 4-4. Wastewater Land Application Systems in the Savannah River Basin

Facility Name	County	Permit No.	Permitted Flow (MGD)
Atlanta International Drag	Banks	GA02-023	0.070
Banks Co Industrial	Banks	GA02-181	0.045
Banks Co Synthetic Ind	Banks	GA02-210	0.011
Coastal Water & Sewer Co	Effingham	GA02-234	
Columbia Co Detention Center	Columbia	GA02-002	0.010
Crider Poultry Lincoln	Lincoln	GA01-570	0.110
Dearing Las	McDuffie	GA02-007	0.090
Fieldale Corp	Stephens	GA01-369	
Franklin Co Board of Com	Franklin	GA02-065	0.075
Grovetown Las	Columbia	GA02-222	0.580
Hartwell Las	Hart	GA02-114	
Hiltonia Las	Screven	GA02-033	0.044
Kings Point Condominiums	Rabun	GA03-687	0.015
Milliken & Company Las	Franklin	GA01-308	0.005
Mount Vernon Mills Las	Banks	GA01-528	
Norwood Las	Warren	GA02-258	0.050
Savannah Reuse Las	Chatham	GA02-198	2.000
Thomson Las	McDuffie	GA02-252	0.050
Twin Line Dairies Inc	Elbert	GA01-436	0.010

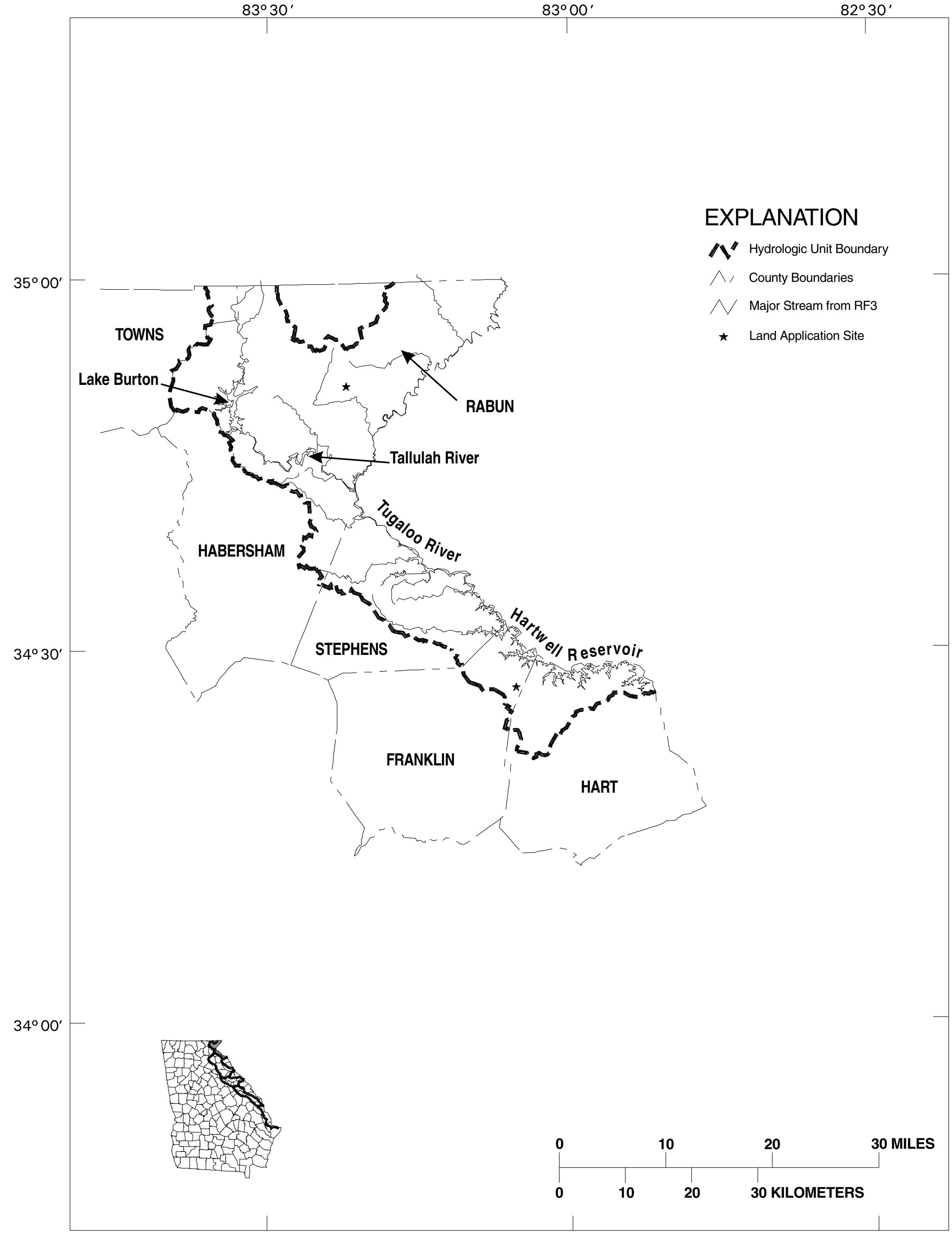

Figure 4-9. Land Application Systems, Savannah River Basin, HUC 03060102

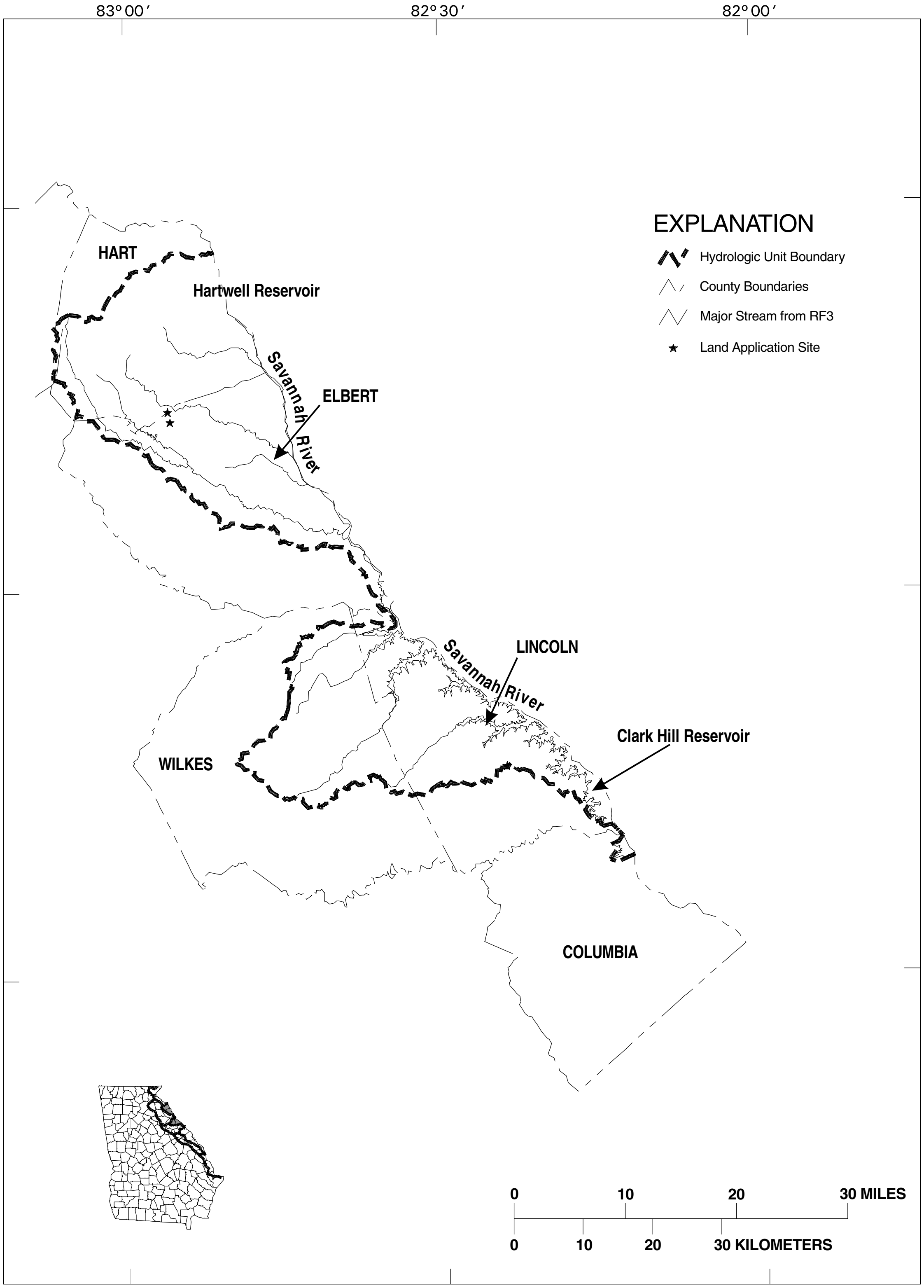

Figure 4-10. Land Application Systems, Savannah River Basin, HUC 03060103

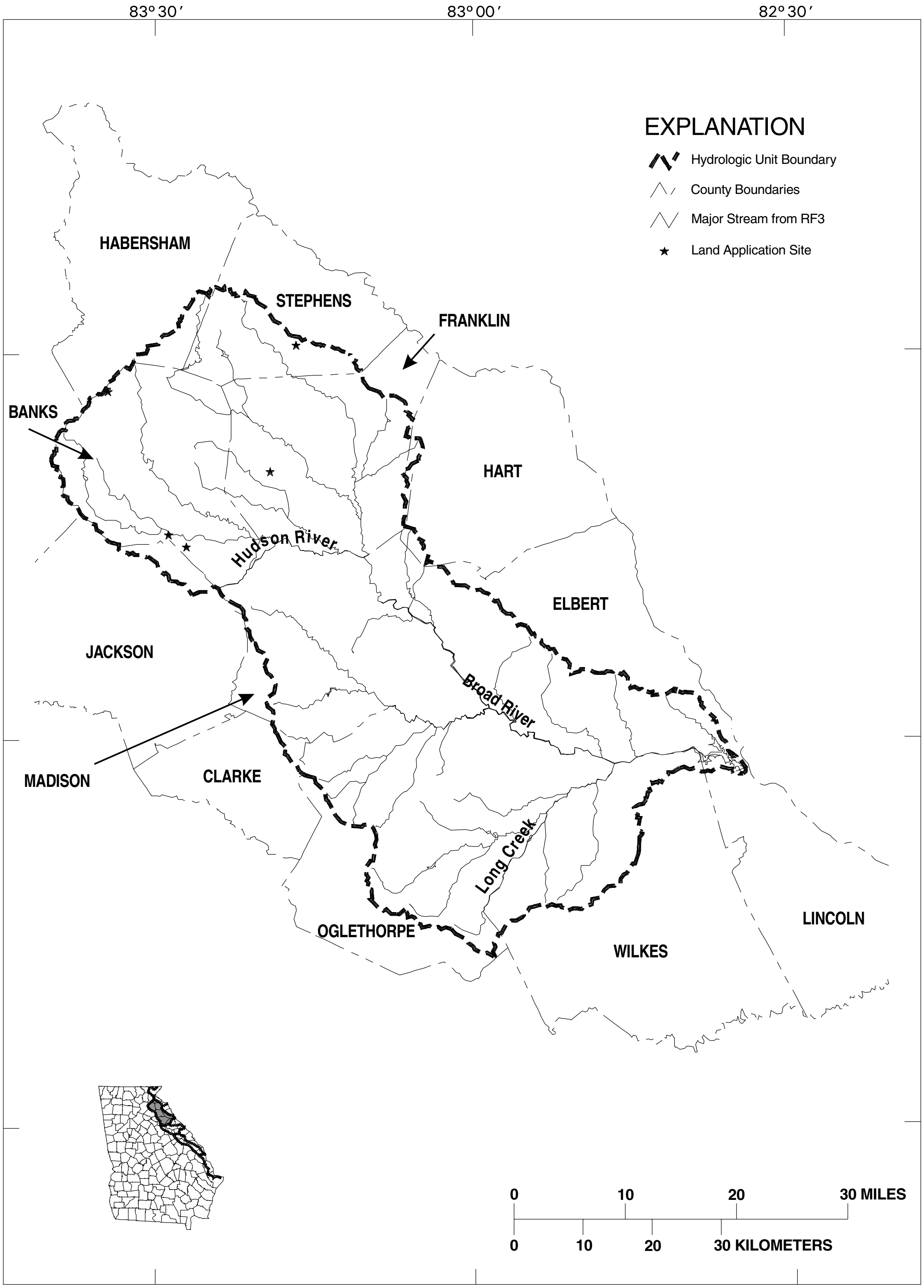

Figure 4-11. Land Application Systems, Savannah River Basin, HUC 03060104

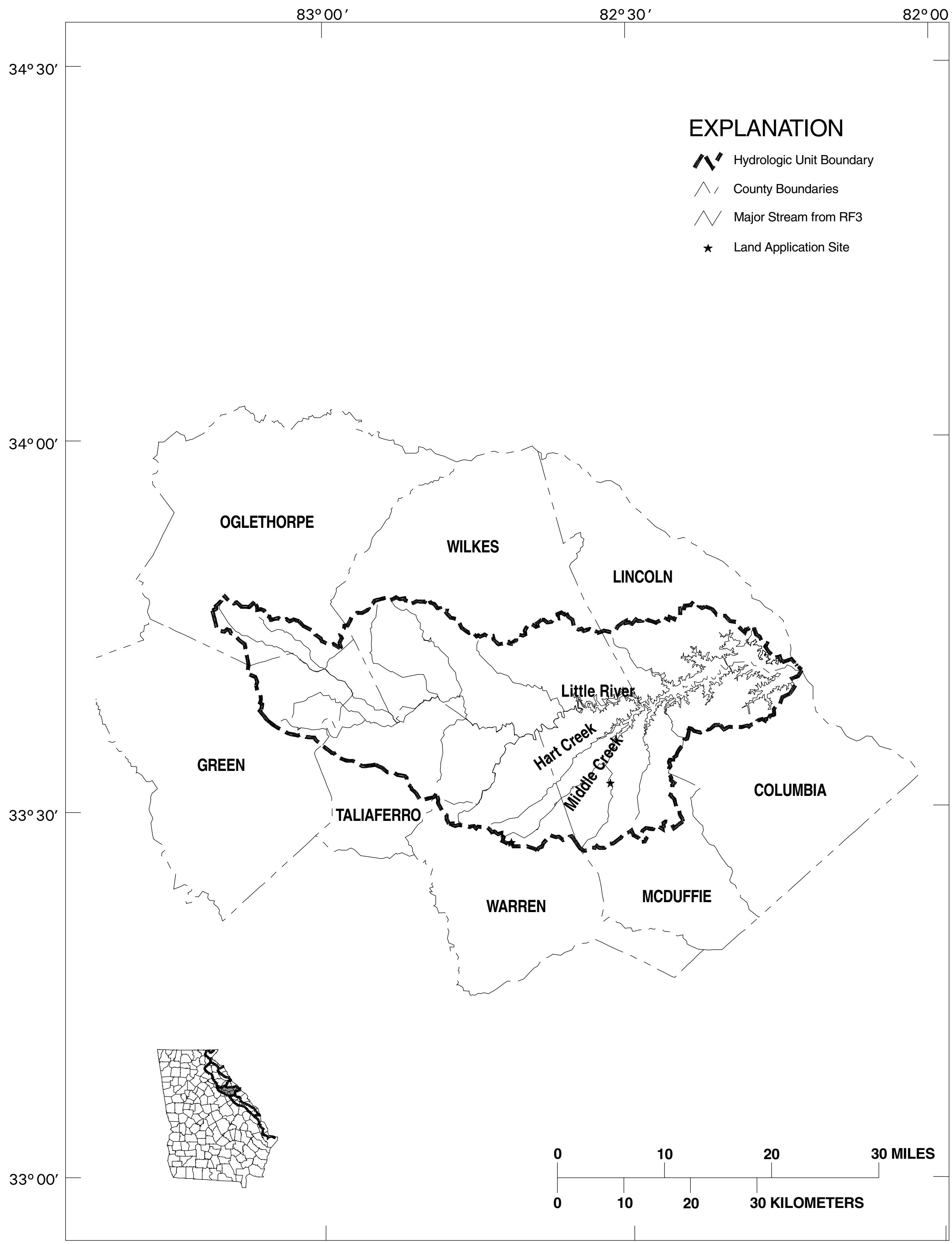

Figure 4-12. Land Application Systems, Savannah River Basin, HUC 03060105

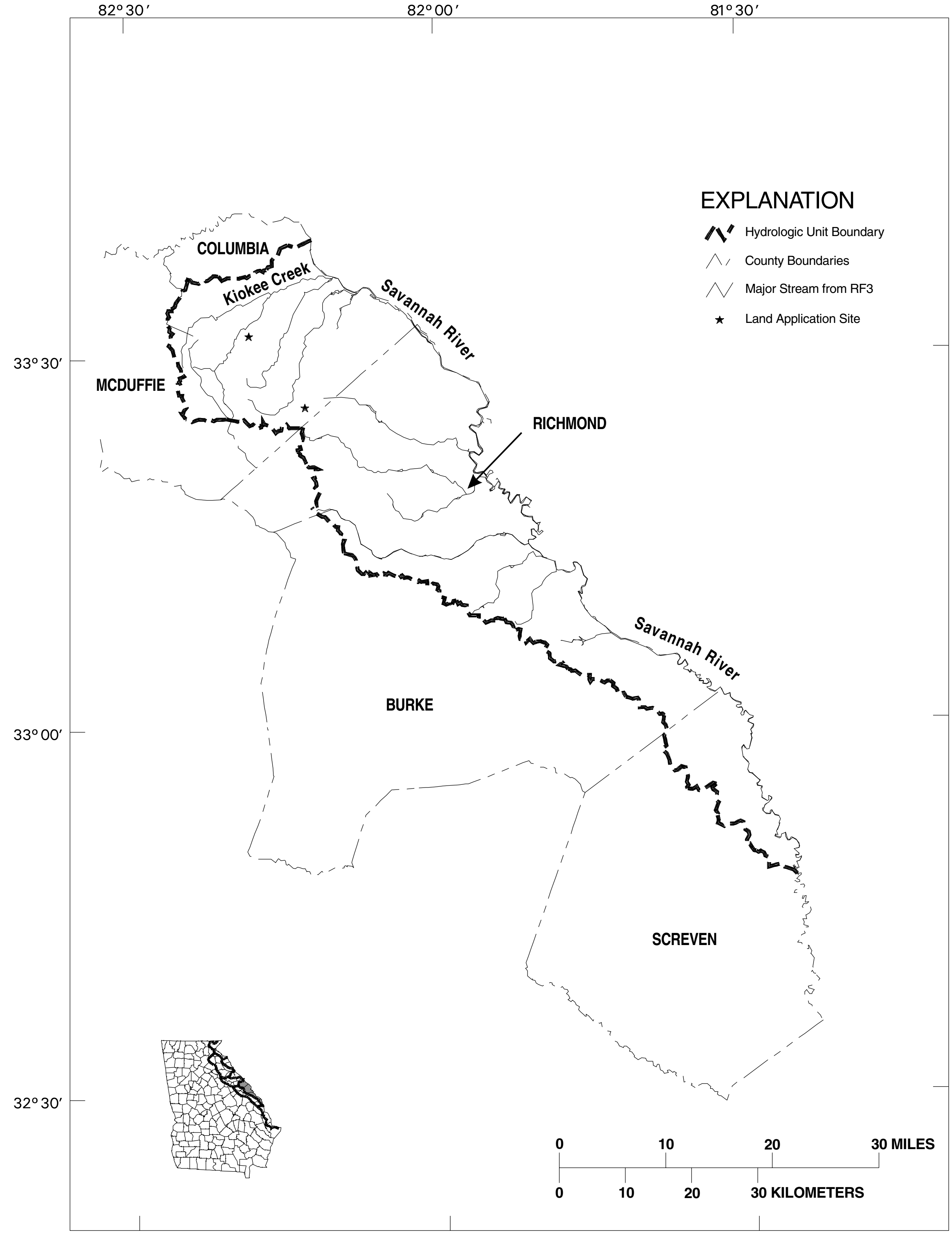

Figure 4-13. Land Application Systems, Savannah River Basin, HUC 03060106

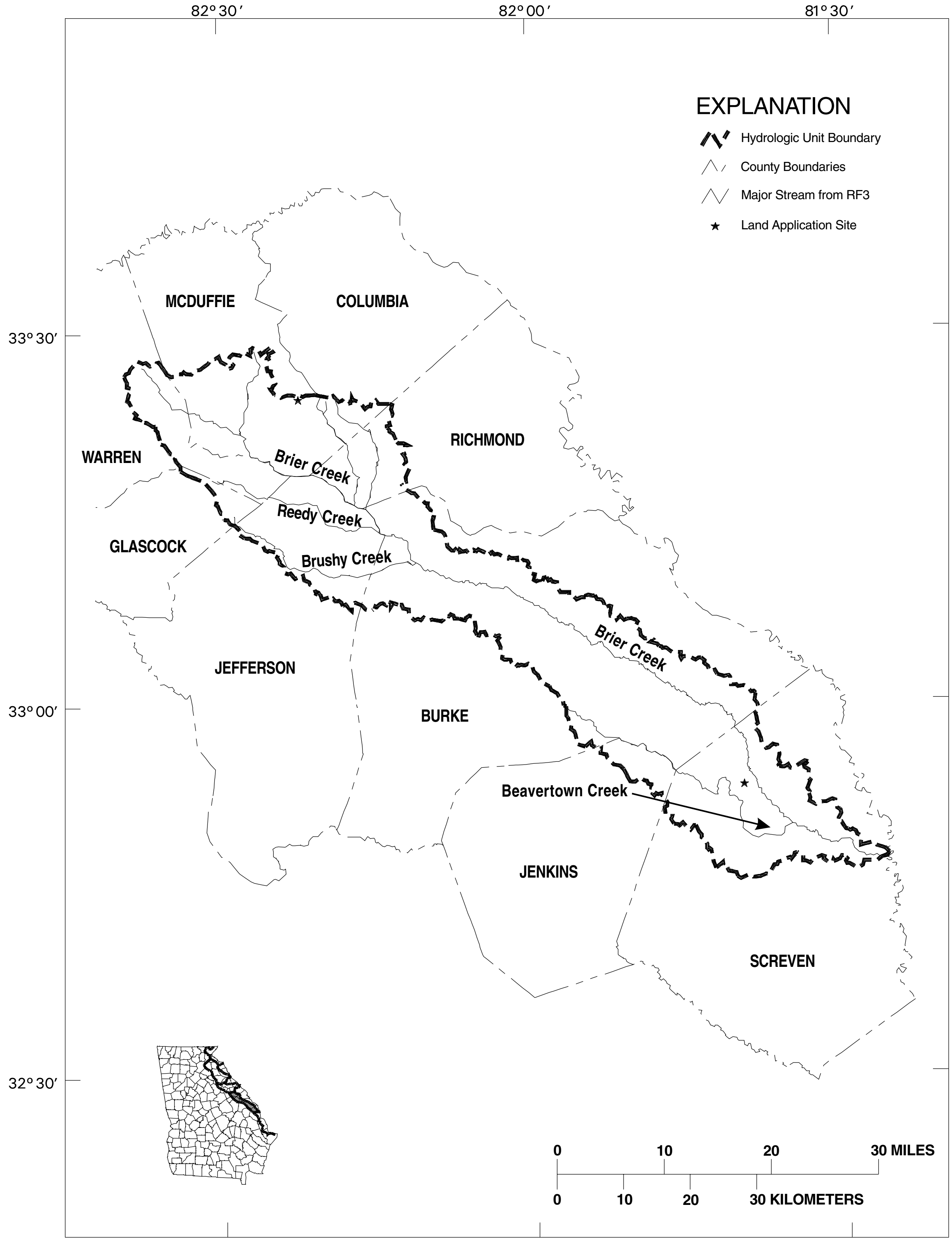

Figure 4-14. Land Application Systems, Savannah River Basin, HUC 03060108

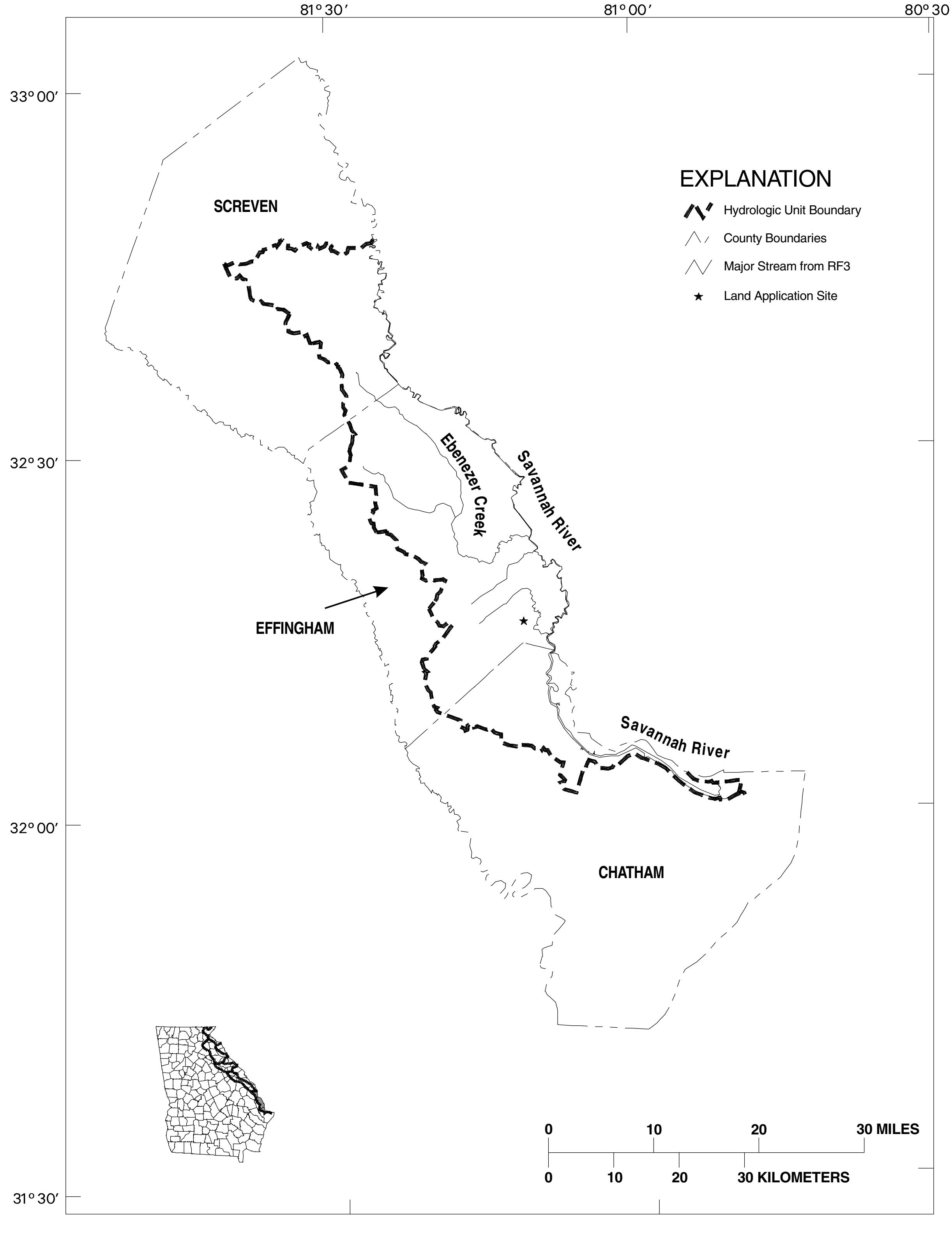

Figure 4-15. Land Application Systems, Savannah River Basin, HUC 03060109

Landfills

Permitted landfills are required to contain and treat any leachate or contaminated runoff prior to discharge to any surface water. The permitting process encourages either direct connection to a publicly owned treatment works (although vehicular transportation is allowed in certain cases) or treatment and recirculation on site to achieve a no-discharge system. Direct discharge in compliance with NPDES requirements is allowed but is not currently practiced any landfills in Georgia. Groundwater contaminated by landfill leachate from older, unlined landfills represents a potential threat to waters of the state. Ground water and surface water monitoring and corrective action requirements are in place for all landfills operated after 1988 to identify and rededicate potential threats. The provisions of the Hazardous Sites Response Act address threats posed by older landfills as releases of hazardous constituents are identified. All new municipal solid waste landfills are required to be lined and to have a leachate collection system installed.

EPD's Land Protection Branch is responsible for permitting and compliance of municipal and industrial Subtitle D landfills. The location of permitted landfills within the basin is shown in Figure 4-16 through 4-22 and Table 4-5.

4.1.2 Nonpoint Sources

The pollution impact on Georgia's streams has radically shifted over the last two decades. Steams are no longer dominated by untreated or partially treated sewage discharges, which had resulted in little or no oxygen and little or no aquatic life. The sewage is now treated, oxygen levels have recovered, and healthy fisheries have followed. Industrial discharges have also been placed under strict regulation. However, other sources of pollution are still affecting Georgia's streams. These sources are referred to as *nonpoint sources*. Nonpoint sources are diffuse in nature. Nonpoint source pollution can generally be defined as the pollution caused by rainfall or snowmelt moving over and through the ground. As water moves over and through the soil, it picks up and carries away natural pollutants and pollutants resulting from human activities, finally depositing them in lakes, rivers, wetlands, coastal waters, or ground water. Habitat alteration (e.g., removal of riparian vegetation) and hydrological modification (e.g., channelization, bridge construction) can also cause adverse effects on the biological integrity of surface waters and are also treated as nonpoint sources of pollution.

Nonpoint pollutant loading comprises a wide variety of sources not subject to point source control through NPDES permits. The most significant nonpoint sources are those associated with precipitation, washoff, and erosion, which can move pollutants from the land surface to water bodies. A review of the 1998-1999 water quality assessment results for the Savannah basin indicates that urban runoff and rural nonpoint sources contribute significantly to lack of full support for designated uses. The major categories of stressors for nonpoint sources are discussed below.

Nonpoint Sources from Agriculture

Agricultural operations can contribute stressors to water bodies in a variety of ways. Tillage and other soil-disturbing activities can promote erosion and loading of sediment to water bodies unless controlled by management practices. Nutrients contained in fertilizers, animal wastes, or natural soils may be transported from agricultural land to streams in either sediment-attached or dissolved forms. Loading of pesticides and pathogens is also of concern for various agricultural operations.

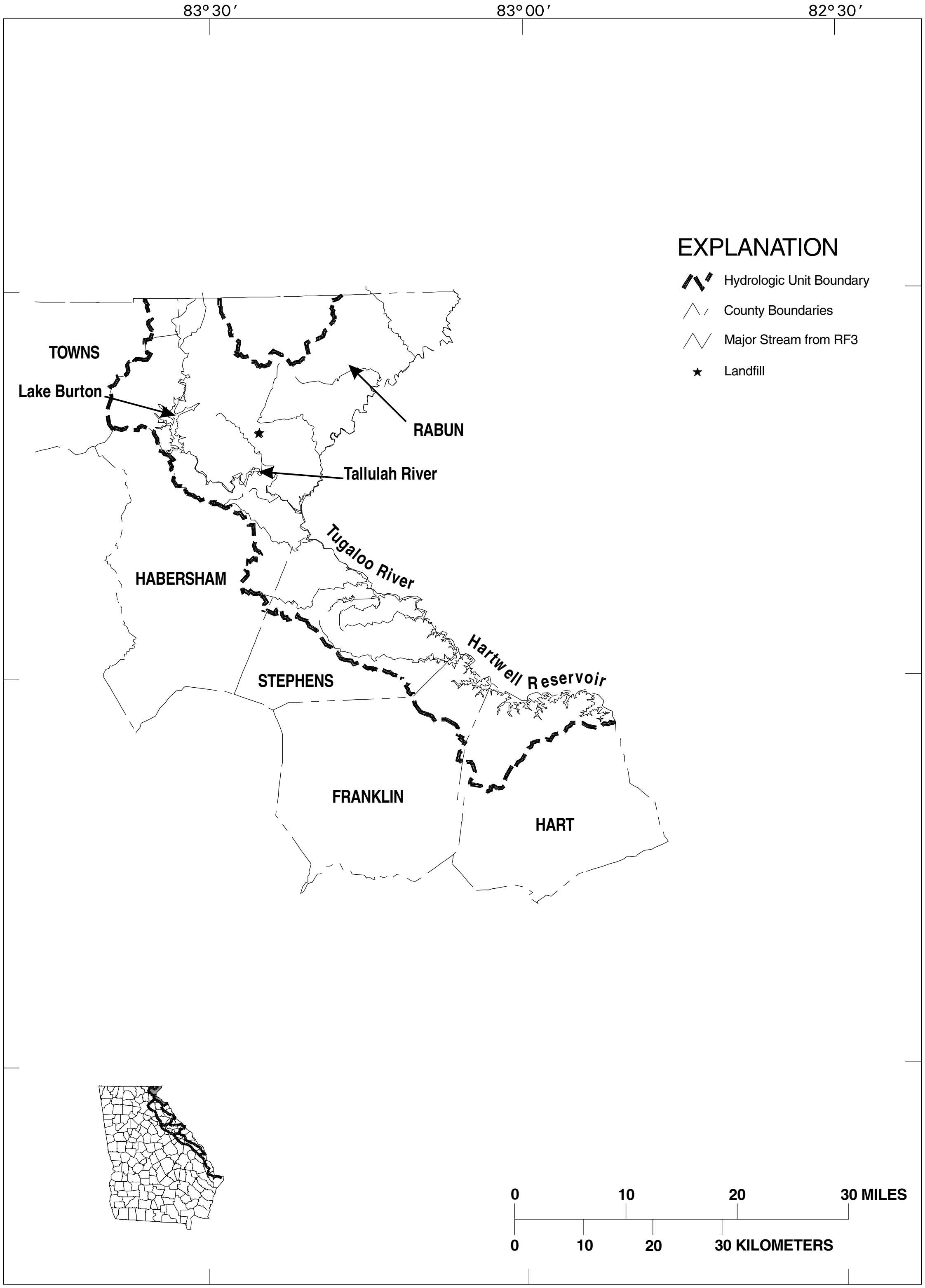

Figure 4-16. Landfills, Savannah River Basin, HUC 03060102

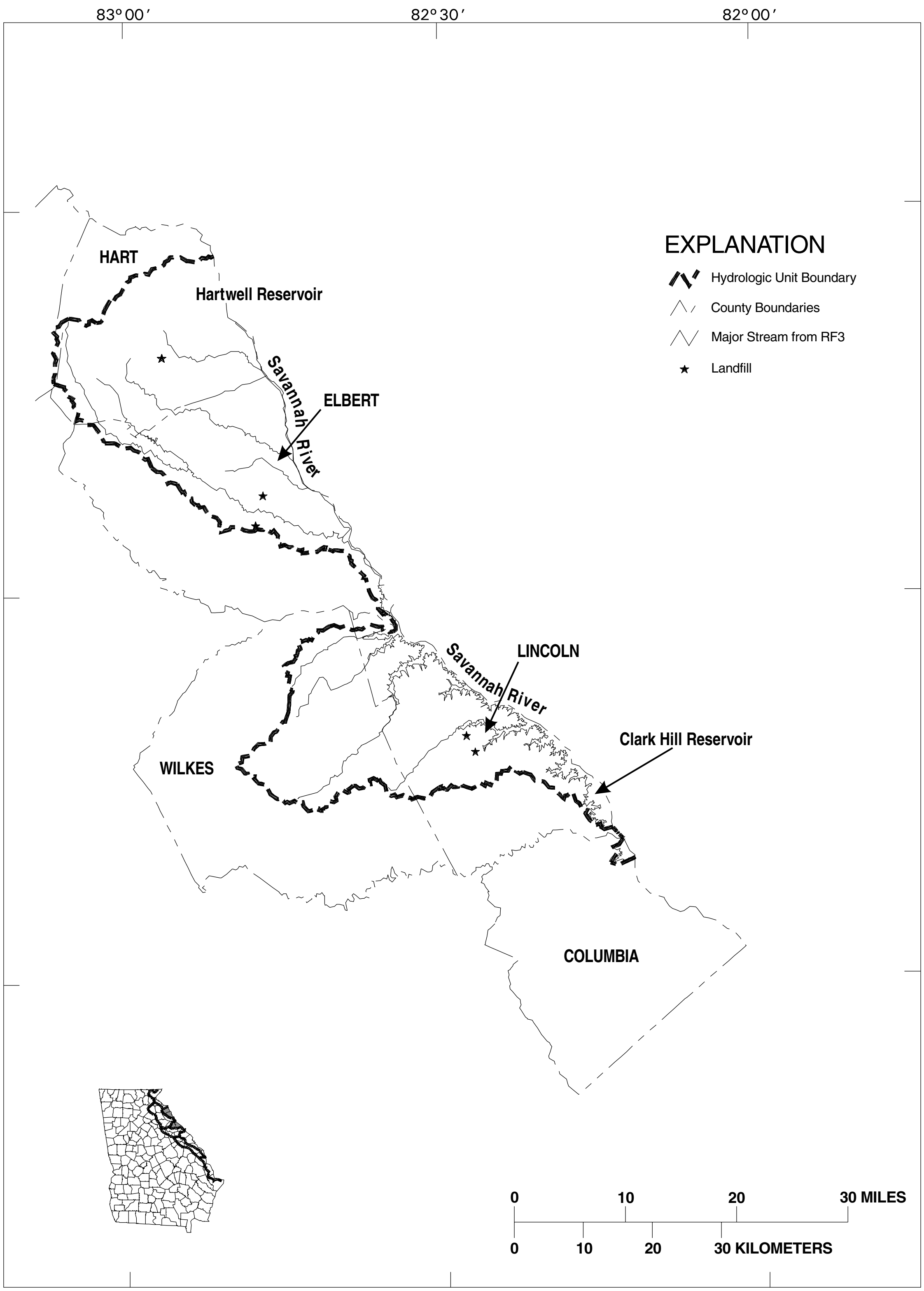

Figure 4-17. Landfills, Savannah River Basin, HUC 03060103

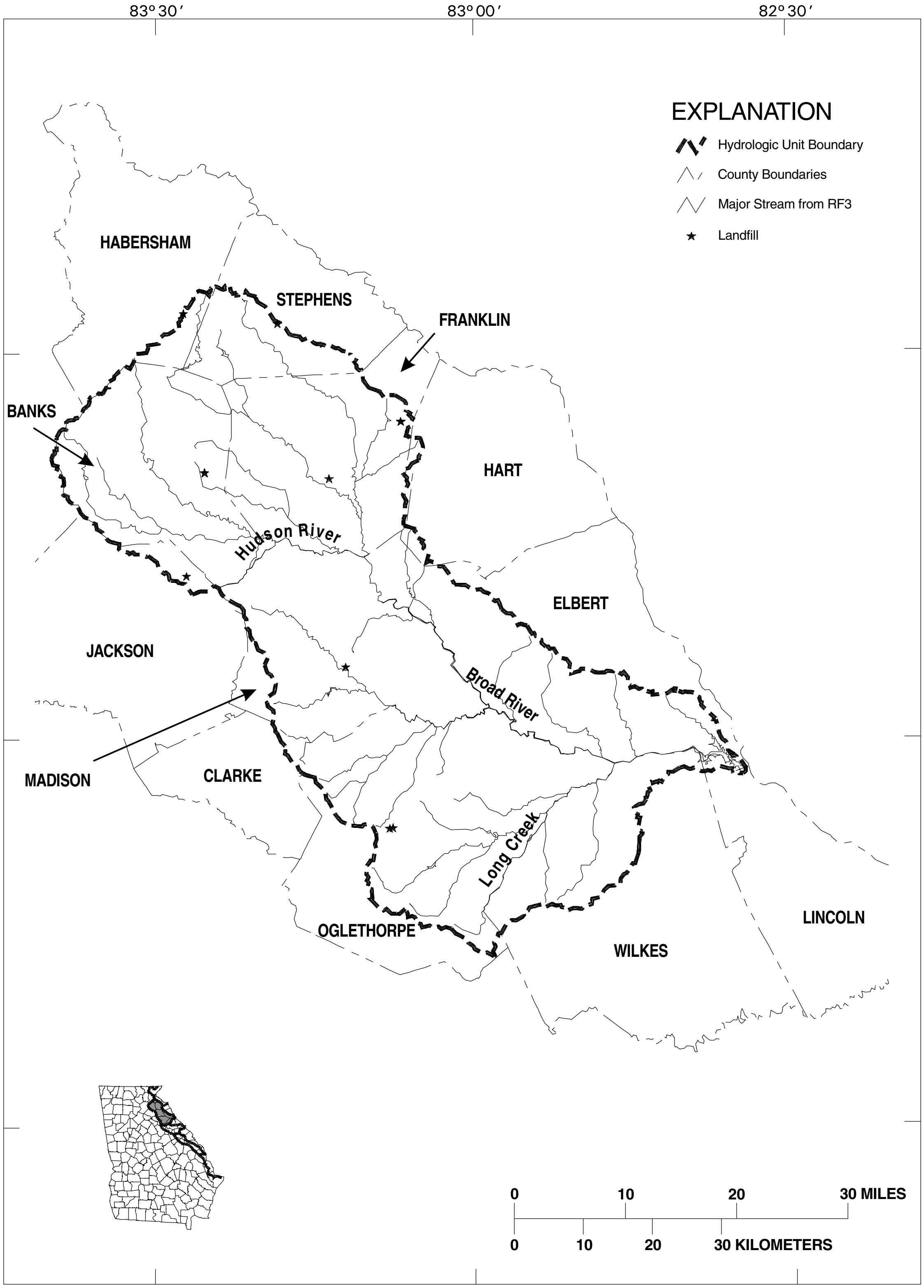

Figure 4-18. Landfills, Savannah River Basin, HUC 03060104

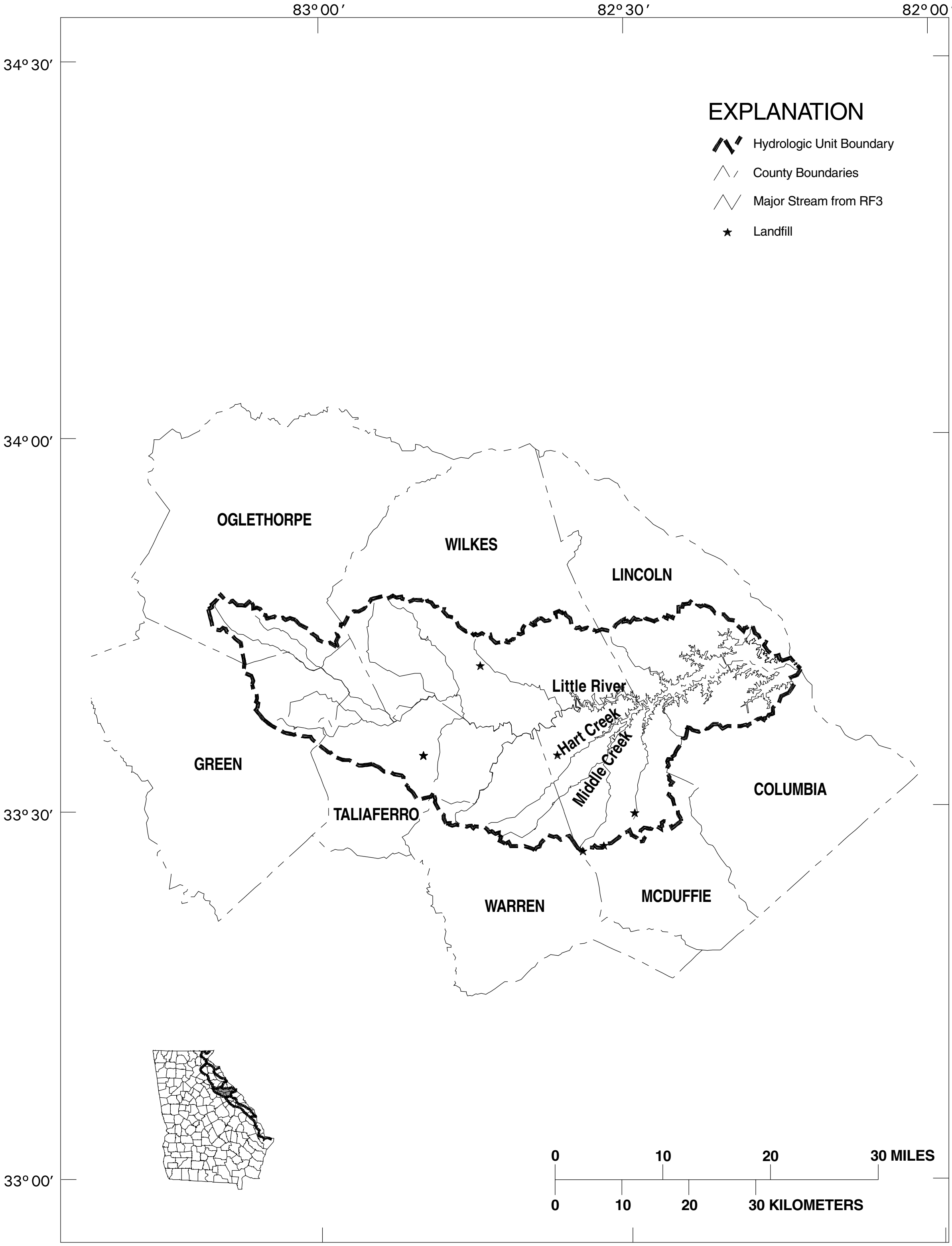

Figure 4-19. Landfills, Savannah River Basin, HUC 03060105

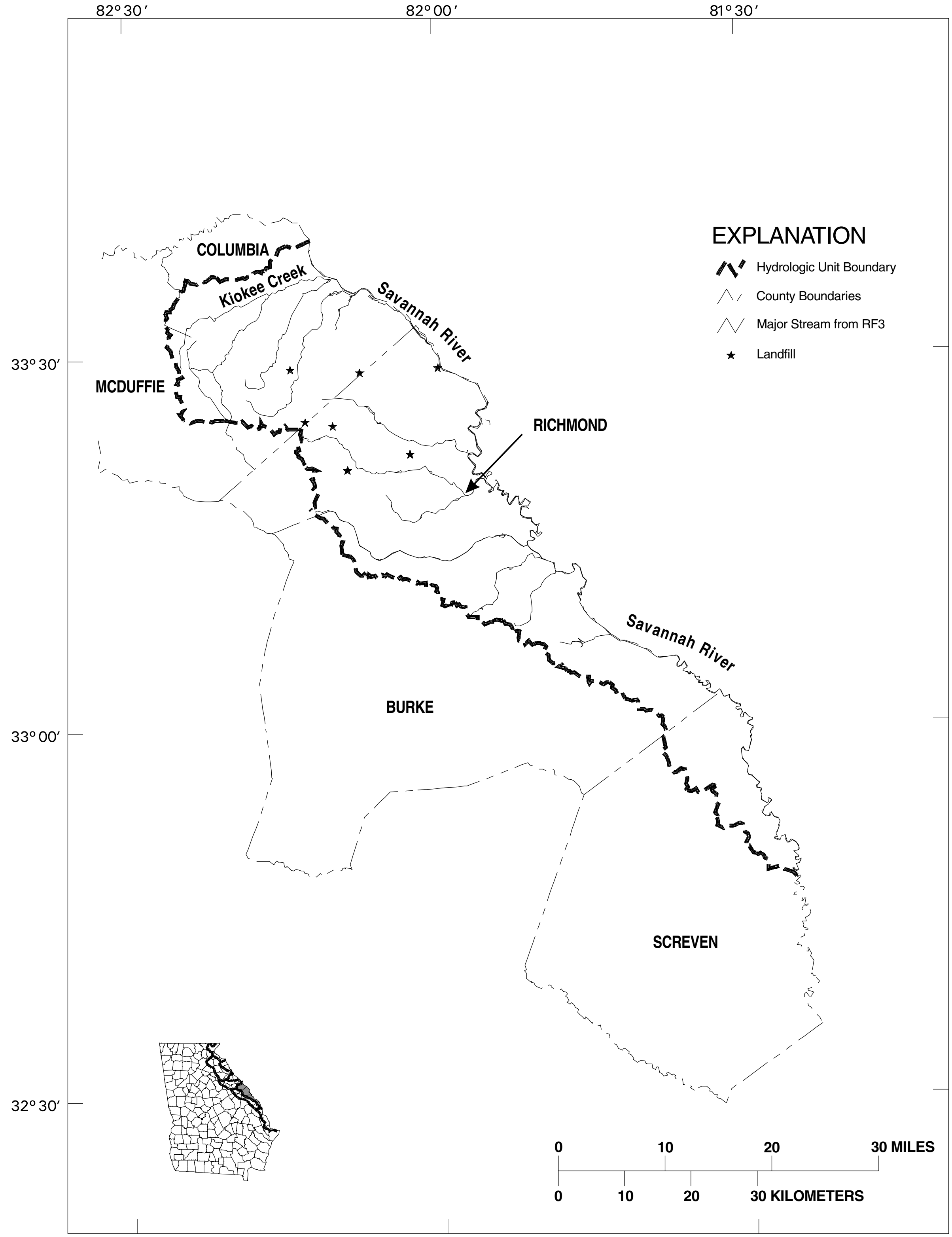

Figure 4-20. Landfills, Savannah River Basin, HUC 03060106

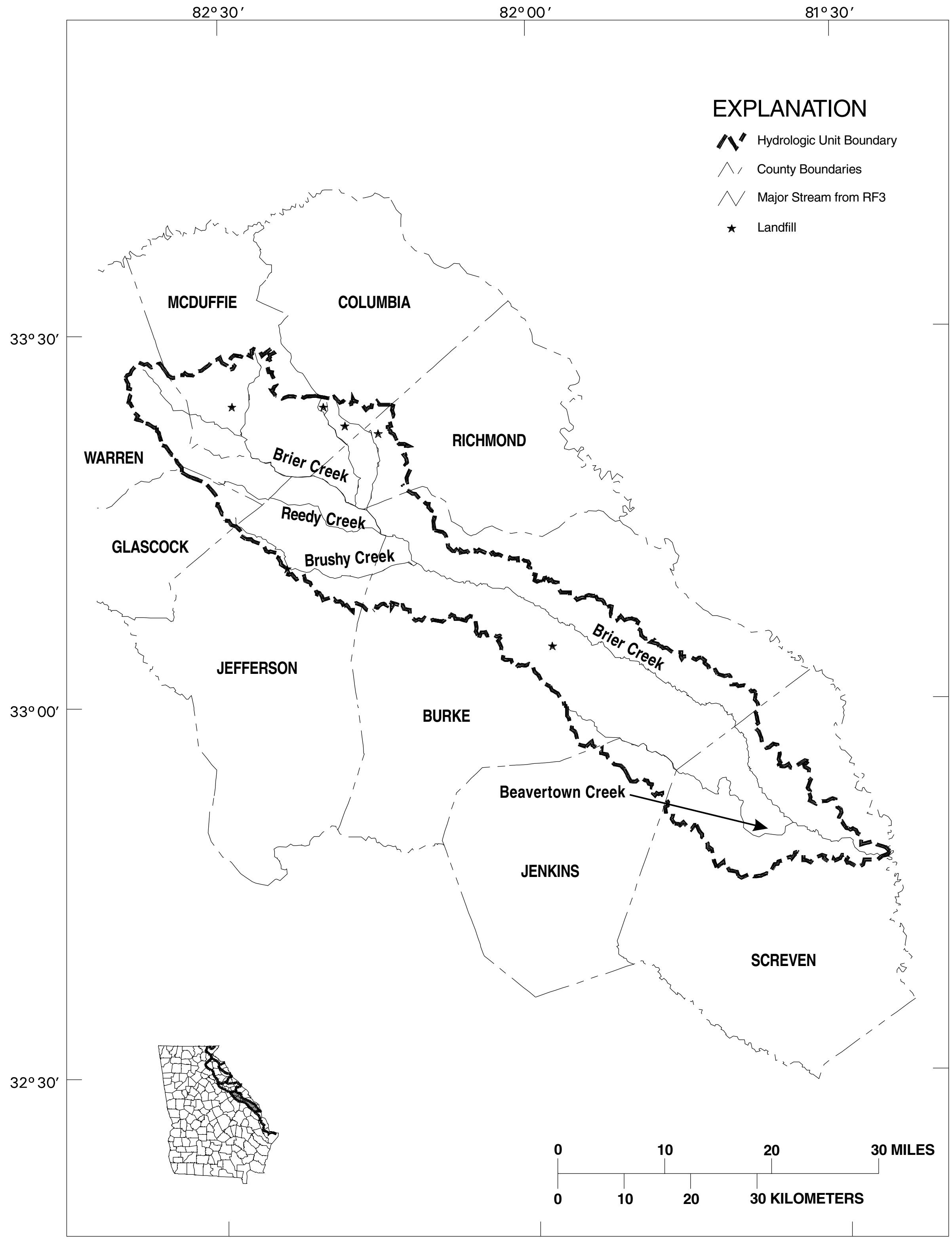

Figure 4-2l. Landfills, Savannah River Basin, HUC 03060108

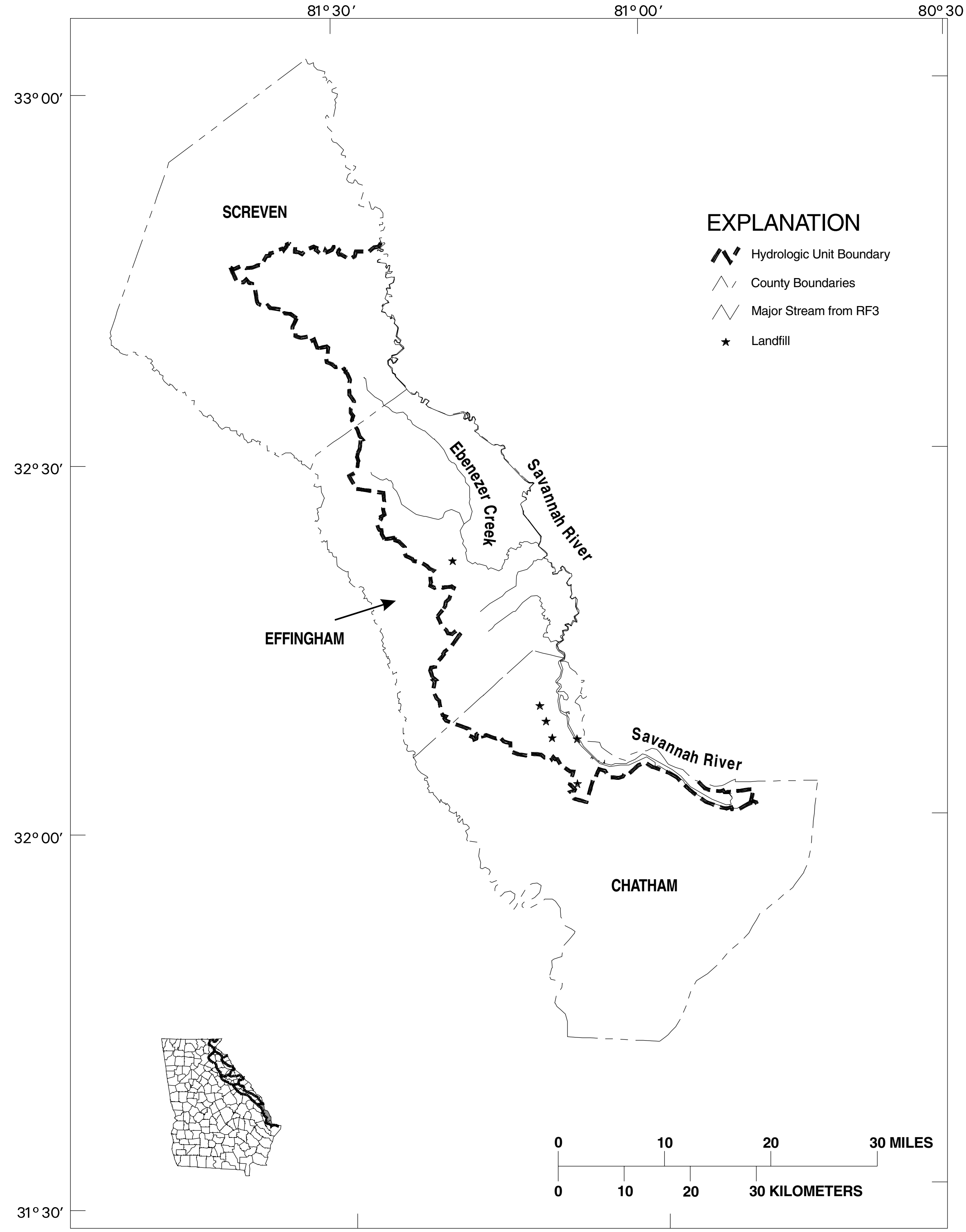

Figure 4-22. Landfills, Savannah River Basin, HUC 03060109

Sediment and Nutrients

Sediment is the most common pollutant resulting from agricultural operations. It consists mainly of mineral fragments resulting from the erosion of soils, but is can also include crop debris and animal wastes. Excess sediment loads can damage aquatic habitat by smothering and shading food organisms, alter natural substrate, and destroying spawning areas. Runoff with elevated sediment concentrations can also scour aquatic habitat, causing significant impacts on the biological community. Excess sediment can also increase water treatment costs, interfere with recreational uses of water bodies, create navigation problems, and increase flooding damage. In addition, a high percentage of nutrients lost from agricultural lands, particularly phosphorus, are transported attached to sediment. Many organic chemicals used as pesticides or herbicides are also transported predominantly attached to sediment.

Agriculture can be a significant source of nutrients, which can lead to excess or nuisance growth of aquatic plants and depletion of dissolved oxygen. The nutrients of most concern from agricultural land uses are nitrogen (N) and phosphorus (P), which may come from commercial fertilizer or land application of animal wastes. Both nutrients assume a variety of chemical forms, including soluble ionic forms (nitrate and phosphate) and less-soluble organic forms. Less soluble forms tend to travel with sediment, whereas more soluble forms move with water. Nitrate-nitrogen is very weakly adsorbed by soil and sediment and is therefore transported entirely in water. Because of the mobility of nitrate-nitrogen, the major route of nitrate loss is to streams by interflow or ground water in deep seepage.

Phosphorus transport is a complex process that involves different components of phosphorus. Soil and sediment contain a pool of adsorbed phosphorus, which tends to be in equilibrium with the phosphorus in solution (phosphate) as water flows over the soil surface. The concentrations established in solution are determined by soil properties and fertility status. Adsorbed phosphorus attached to soil particles suspended in runoff also equilibrates with phosphorus in solution.

In 1993, the Soil Conservation Service (SCS, now NRCS) completed a study to identify hydrologic units in Georgia with a high potential for nonpoint source pollution problems resulting from agricultural land uses (SCS 1993). This study concluded that there is not a major statewide agricultural pollution problem in Georgia. However, the assessment shows that some watersheds have sufficient agricultural loading to potentially impair their designated uses, based on estimates of transported sediments, nutrients, and animal wastes from agricultural lands (Table 4-6).

In July and August 1996, EPA conducted biological assessments on Georgia watersheds that had sufficient agricultural loading to potentially impair designated stream use to determine which of those waters should be added to Georgia’s Section 303(d) list of streams with water quality limited segments. Those waters identified by EPA as potentially impaired by agricultural nonpoint source loading and added to the 303(d) list in December 1996 are shown in Table 4-7. The EPA will develop total maximum daily loads (TMDLs) for these waters in 2004.

Animal Waste

In addition to contributing to nutrient loads, animal waste may contribute high loads of oxygen-demanding chemicals and bacterial and microbial pathogens. The waste may reach surface waters through direct runoff as solids or in their soluble form. Soluble forms may reach ground water through runoff, seepage, or percolation and reach surface waters as return flow. As the organic materials decompose, they place an oxygen demand

Table 4-5. Estimated Loads from Agricultural Lands by County (SCS, 1993)

County	Percent of Area in Basin	Acres with Nutrient Application	Sediment (tons)	Sediment (ppm)	Nitrogen (tons)	Nitrogen (ppm)	Phosphorus (tons)	Phosphorus (ppm)
Banks	100	33,302	26,541	27.3	323	0.34	71	0.074
Burke	62	140,992	144,222	28.9	411	0.12	153	0.045
Chatham	33	5,874	495	2.2	3	0.02	1	0.007
Columbia	100	10,066	5,781	18.4	21	0.07	8	0.03
Effingham	72	36,182	14,798	10.4	48	0.04	18	0.014
Elbert	100	42,288	60,755	36.7	207	0.17	76	0.063
Franklin	100	64,549	67,697	35.7	559	0.31	135	0.074
Glascock	12	15,382	4,744	19.1	15	0.09	6	0.033
Greene	21	34,138	5,840	6	62	0.06	20	0.021
Habersham	12	36,763	57,644	54.8	489	0.48	99	0.095
Hall	5	44,459	33,924	26.8	453	0.36	87	0.07
Hart	100	56,284	104,053	55.9	365	0.23	130	0.082
Jackson	8	57,347	37,374	21.3	423	0.26	101	0.062
Jefferson	20	94,553	112,866	39.3	342	0.15	121	0.053
Jenkins	5	56,007	68,295	34.6	233	0.17	80	0.06
Lincoln	100	23,180	6,623	9.3	35	0.05	12	0.018
Madison	96	54,858	74,106	43.5	481	0.31	72	0.046
McDuffie	100	25,874	32,994	44.4	199	0.27	78	0.107
Oglethorpe	84	41,384	31,518	24.6	315	0.27	84	0.072
Richmond	100	17,275	9,943	19.6	32	0.08	11	0.028
Screven	58	106,179	96,731	29.1	272	0.1	103	0.04
Stephens	100	13,088	22,934	61.5	120	0.33	35	0.095
Taliaferro	66	12,746	5,588	15	23	0.06	8	0.022
Towns	10	9,610	17,201	33.7	52	0.1	22	0.043
Warren	49	35,845	29,881	20.7	93	0.09	35	0.035
Wilkes	100	67,383	40,966	20.6	225	0.12	78	0.041

Note: Mass estimates are based on whole county. Concentration estimates are average event runoff concentration from agricultural lands.

Table 4-6. Waters Identified as Potentially Impacted by Agricultural Nonpoint Source Loading and Added to the Georgia 303[d] List

Waterbody	County	Pollutant[s] of Concern
South Fork Broad River	Madison and Oglethorpe	Biota
South River	Madison	Biota, Sediment
Broad River	Madison	Biota, Habitat
Middle Fork Broad River	Franklin, Habersham, Stephens	Habitat
Lower North Fork Broad River	Franklin, Habersham, Stephens	Biota, Habitat
North Fork Broad River	Franklin and Stephens	Habitat
Lake Hartwell Tributaries		
Crawford Creek	Franklin and Hart	Biota
Little Crawford Creek	Franklin and Hart	Biota, Habitat
Little Shoal Creek	Franklin and Hart	Biota, Habitat
Flat Shoals	Franklin and Hart	Habitat
Toccoa Creek	Stephens	Biota

on the receiving waters, which may adversely affect fisheries, and cause other problems with taste, odor, and color. When waters are contaminated by waste from mammals the possible presence of pathogens that affect human health, include fecal bacteria, is of particular concern. In addition to being a source of bacteria, cattle waste might be an important source of the infectious oocysts of the protozoan parasite *Cryptosporidium parvum*.

Pesticides

Pesticides applied in agricultural production can be insoluble or soluble and include herbicides, insecticides, miticides, and fungicides. They are primarily transported directly through surface runoff, either in dissolved forms or attached to sediment particles. Some pesticides can cause acute and chronic toxicity problems in the water or throughout the entire food chain. Others are suspected human carcinogens, although the use of such pesticides has generally been discouraged in recent years.

The major agricultural pesticide/herbicides use within the basin include 2,4-d, Prowl, Blazer/Basagran/Trifluralin/Treflan/Trilin, Aatrex/Atizine, Gramoxone, Classic, Lexone/Sencor, and Lasso (alachlor) (compiled from the Georgia Herbicide Use Survey summary [Monks and Brown, 1991]). Since 1990, the use of alachlor in Georgia has decreased dramatically since peanut wholesalers no longer buy peanuts with alachlor.

Nonherbicide pesticide use is difficult to estimate. According to Stell et al. (1995), pesticides other than herbicides are currently used only when necessary to control some type of infestation (nematodes, fungi, and insects). Other common nonherbicie pesticides include chlorothalonil, aldicarb, chlorpyifos, methomyl, thiodicarb, carbaryl, acephate, fonofos, methyl parathion, terbufos, disulfoton, phorate, triphenyltin hydroxide (TPTH), and synthetic pyrethroids/pyrethrins. Application periods of principal agricultural pesticides span the calendar year in the basin. However, agricultural pesticides are applied most intensively and on a broader rang of crops from March 1 to September 30 in any given year.

It should be noted that past uses of persistent agricultural pesticides that are now banned might continue to affect water quality within the basin, particularly through residual concentrations present in bottom sediments. A survey of pesticide concentration data by Stell et al. (1995) found that two groups of compounds had concentrations at or above minimum reporting levels in56 percent of the water and sediment analyses. The first group included DDT and metabolites, and the second group included chlordane and related compounds (heptachlor, heptachlor epoxide)—while dieldrin was also frequently detected. The USEPA now bans all of these pesticides for use in the United States, but they might persist in the environment for long periods of time.

Nonpoint Sources from Urban, Industrial, and Residential Lands

Water quality in urban waterbodies is affected by both point source discharges and diverse land use activities in the drainage basin (i.e., nonpoint sources). One of the most important sources of environmental stressors in the Savannah River basin, particularly in the developed and rapidly growing areas is diffuse runoff from urban, industrial, and residential land uses (jointly referred to as “urban runoff”). Nonpoint source contamination an impair streams that drain extensive commercial and industrial areas due to inputs of storm water runoff, unauthorized discharges, and accidental spills. Wet weather urban runoff can carry high concentrations of many of the same pollutants found in point source discharges, such as oxygen-demanding waste, suspended solids, synthetic organic chemicals, oil and grease, nutrients, lead and other metals, and bacteria The major difference is that urban runoff occurs only intermittently, in response to precipitation events.

The characteristics of nonpoint urban sources of pollution are generally similar to those of NPDES permitted storm water discharges (these are discussed in the previous section). Nonpoint urban sources of pollution include drainage from areas with impervious surfaces, but also includes less highly developed areas with greater amounts of pervious surfaces such as lawns, gardens, and septic tanks, all of which may be sources of nutrient loading.

There is little site-specific data available to quantify loading in nonpoint urban runoff in the Savannah River basin, although estimates of loading rates by land use types have been widely applied in other areas.

Pesticides and Herbicides from Urban and Residential Lands

Urban and suburban land uses are also a potential source of pesticides and herbicides through application to lawns and turf, roadsides, and gardens and beds. Stell et al. (1995) provide a summary of usage in the Atlanta Metropolitan Statistic Area (MSA). The herbicides most commonly used by the lawn-care industry are combinations of dicamba, 2,4-D, mecoprop (MCPP), 2,4-DP, and MCPA, or other phenoxy-acid herbicides, while most commercially available weed control products contain one or more of the following compounds: glyphosphate, methyl sulfometuron, benefin (benfluralin), bensulide, acifluorfen, 2,4-D, 2,4-DP, or dicamba. Atrazine was also available for purchase until it was restricted by the State of Georgia on January 1, 1993. The main herbicides used by local and state governments are glyphosphate, methyl sulfometuron, MSMA, 2,4-D, 2,4-DP, dicamba, and chlorsulforon. Herbicides are used for preemergent control of crabgrass in February and October, and in the summer for postemergent control. Data from the 1991 Georgia Pest Control Handbook (Delaplane, 1991) and a survey of CES and SCS personnel conducted by Stell et al. Indicate that several insecticides could be considered ubiquitous in urban/suburban use, including chlorpyrifos, diazinon, malathion, acephate, carbaryl, lindane, and dimethoate. Chlorothalonil, a fungicide, is also widely used in urban and suburban areas.

Other Urban/Residential Sources

Urban and residential storm water also potentially includes pollutant loads from a number of other terrestrial sources:

Septic Systems. Poorly sited and improperly operating septic systems can contribute to the discharge of pathogens and oxygen-demanding pollutants to receiving streams. This problem is addressed through septic system inspections by the appropriate County Health Department, extension of sanitary sewer service and local regulations governing minimum lot sizes and required pump-out schedules for septic systems.

Leaking Underground Storage Tanks. The identification and remediation of leaking underground storage tanks (LUSTs) is the responsibility of the EPD Land Protection Branch. Petroleum hydrocarbons and lead are typically the pollutants associated with LUSTs.

Nonpoint Sources from Forestry

Silvicultural operations may serve as sources of stressors, particularly excess sediment loads to streams, when Best Management Practices (BMPs) are not followed. From a water quality standpoint, woods roads pose the greatest potential threat of any of the typical forest practices. It has been documented that 90 percent of the sediment that entered streams from a forestry operation was directly related to either poorly located or poorly constructed roads. The potential impact to water quality from erosion and sedimentation is increased if BMPs are not adhered to.

Silviculture is also a potential source of pesticides/herbicides. According to Stell et al. (1995), pesticides are mainly applied during site preparation after clear-cutting and during the first few years of new forest growth. Site preparation occurs on a 25-year cycle on most pine plantation land, so the area of commercial forest with pesticide application in a given year is relatively small. The herbicides glyphosate (Accord), sulfometuron methyl (Oust), hexazinone (Velpar), imazapyr (Arsenal), and metsulfuron methyl (Escort) account for 95 percent of the herbicides used for site preparation to control grasses, weeds, and broadleaves in pine stands. Dicamba, 2,4-D, 2,4,-DP (Banvel), triclopyr (Garlon), and picloram (Tordon) are minor use chemicals used to control hard to kill hardwoods and kudzu. The use of triclopyr and picloram has decreased since the early 1970's.

Most herbicides are not mobile in the soil and are targeted to plants, not animals. Applications made following the label and in conjunction with BMPs should pose little threat to water quality.

Chemical control of insects and diseases is not widely practices except in forest tree nurseries which is a very minor land use. Insects in pine stands are controlled by chlorpyrifos, diazinon, malathion, acephate, carbaryl, lindane, and dimethoate. Diseases are controlled using chlorothalonil, dichloropropene, and mancozeb. There are no commercial forest tree nurseries within the basin.

According to the Water Quality in Georgia 1998 Report, no streams were identified in the basin as impacted due to commercial forestry activities.

Statewide BMP Implementation Survey

In 1992 the Georgia Forestry Commission conducted a statewide BMP implementation survey to determine to what extent forestry BMPs were being implemented. Within the Savannah Basin, the GFC evaluated 35 sites involving 4,464 acres of land. Of the sites evaluated, 19 sites involving 1,826 acres were on private lands, 13 sites involving 1,935 acres were on forest industry land, and 3 sites involving 700 acres were on public lands. Overall compliance with BMPs was 85 percent. By ownership, compliance was approximately 81 percent on private lands, 85 percent on forest industry lands, and 96 percent on public lands.

Approximately 75 percent of the 25.2 miles of main haul roads evaluated on 30 sites were in compliance with BMPs. Most noted problems were that roads did not follow the contour on 44 percent of the sites and water diversions were used to slow surface water flow and divert the flow out of the road only on 50 percent of the sites. Main haul roads crossed streams on 38 percent of the sites and culverts were sized correctly for the watershed on 83 percent of the sites. Forty four percent of the crossings were located at too steep of grades and 56 percent were not stabilized correctly. Water bars were installed in temporary roads only on 25 percent of the sites. By ownership, road compliance for private lands was 63 percent, forest industry was 81 percent, and public lands was 100 percent.

Approximately 85 percent of the 4,461 harvested acres evaluated on the 35 sites were in compliance with BMPs. Problem areas were that water bars were not installed in skid trails on sites with sloping terrain. Only 54 percent of the log decks were stabilized. Equipment was improperly serviced on 11 percent of the sites. Harvesting within the Streamside Management Zones (SMZs) occurred on 64 percent of the sites and resulted in 44 percent of the SMZs rutted or damaged and excess logging debris was left in the streams on 44 percent of the sites. Log decks were properly located outside of the recommended SMZ on 96 percent of the sites. Temporary stream crossings occurred on 21 percent of the sites and none were properly removed after the harvest. By ownership, harvesting compliance for private lands was 81 percent, forest industry was 85 percent, and public lands was 95 percent.

Approximately 100 percent of the 70 site prepared acres evaluated on one site were in compliance with BMPs. By ownership, site preparation compliance for private lands was 100 percent.

Atmospheric Deposition

Atmospheric deposition can be a significant source of nitrogen and acidity in watersheds. Nutrients from atmospheric deposition, primarily nitrogen, are distributed throughout the entire basin in precipitation. The primary source of nitrogen in atmospheric deposition is nitrogen oxide emissions from combustion of fossil fuels. The rate of atmospheric deposition is a function of topography, nutrient sources, and spatial and temporal variations in climatic conditions.

Atmospheric deposition can also be a source of certain mobile toxic pollutants, including mercury, PCBs, and other organic chemicals.

4.1.3 Flow and Temperature Modification

Many species of aquatic life are adapted to specific flow and temperature regimes. In addition, both flow and temperature affect the dissolved oxygen balance in water, and changes in flow regime can have important impacts on physical habitat. Temperature is particularly critical for the coldwater trout fishery. Georgia is located at the extreme southern edge of trout habitat, and therefore many trout waters approach or exceed maximum tolerable temperatures during the hottest summer months, even under natural conditions. Trout need cold water to survive and reproduce well, so any practices that cause stream warming can have adverse effects.

Thus, flow and temperature modifications can be important environmental stressors. They also interact with one another to affect the oxygen balance: flow energy helps control reaeration rate, while water temperature controls the solubility of dissolved oxygen, and higher water temperatures reduce oxygen solubility and thus tend to reduce dissolved oxygen concentrations. Further, increased water temperature increases the rate of metabolic activity in natural waters, which in turn may increase oxygen consumption by aquatic species.

Flow Modification

Flows from Clarks Hill Dam are primarily driven by hydropower generation schedules for supply of electricity during peak demand times. Weekday generation flows typically range from 8,000 to 20,000 cfs. Releases of 30,000 cfs are not uncommon. Weekend generation flows target a flow of 5800 cfs. When not generating, no minimum flow is provided. Stevens Creek Dam, a run-of-the-river hydropower dam about 15 miles downstream, provides limited re-regulation of flows from Clarks Hill Dam and lessens the impact of high water associated with peak generation. One mile downstream of Stevens Creek Dam, the Augusta Diversion Dam directs a portion of river flow into the Augusta Canal for power and water supply, bypassing six miles of shoals. The combination of peaking flows and flow diversion results in flows that are quite low in the shoals, particularly on weekends (EDAW, 1997). Impacts on juvenile nursery habitat and robust redhorse spawning and rearing habitat are of concern. Also, pool fluctuations in

Stevens Creek Reservoir can be up to 4.5 feet (South Carolina Electric and Gas, 1996), resulting in impacts on spawning fish and access for recreational users.

Temperature

The Savannah basin has many miles of trout waters that are threatened by the impact of small impoundments which can result in increased summer temperatures. Most of the trout streams in the basin are secondary trout streams (they are cold enough to support trout populations, but no natural reproduction occurs) and actual trout fisheries are limited by the supply of trout for stocking. Even small impoundments, if not specifically designed to prevent stream warming, may impact temperatures for several miles downstream.

Another threat to suitable temperature regime in the trout streams of the Savannah River basin is the removal of riparian tree cover, which allows increased warming of water by sunlight. Under natural conditions, smaller streams in Georgia are shaded by a tree canopy. If this canopy is removed the resulting direct sunlight can result in increased water temperatures with adverse effects on native aquatic life. Timber harvest within riparian buffers can thus lead to temperature stress if proper management practices are not followed. Increases in impervious surface area coverage (particularly paved areas) in the watershed also contribute to stream warming. Trout streams in the Savannah basin are also potentially threatened by erosion, sedimentation and temperature impacts.

Hydropower generation at Richard B. Russell Dam consists of four conventional generation units. Four additional generation units with pumpback (reverse flow) capabilities have been installed, mechanically and environmentally tested, and currently in the environmental review process. Test conducted from April to October 1996 increased water temperature in Clarks Hill Lake (U.S. Army Corps of Engineers, Savannah District 1998), negatively impacting critical habitat for striped bass and hybrid (white x striped) bass. Fishing success for these cool water species was reduced during that time period. Long term impacts of elevated water temperatures in Clarks Hill Lake could significantly reduce the already limited summer and early fall habitat currently available for striped and hybrid (white x striped) bass. Trophy striped bass (20-50 lbs) in Clarks Hill Lake would likely cease to exist if the pumpback units are operated without significant mitigation measures.

4.1.4 Physical Habitat Alteration

Many forms of aquatic life are sensitive to physical habitat disturbances. Probably the major disturbing factor is erosion and loading of excess sediment, which changes the nature of the stream substrate. Thus, any land use practices that cause excess sediment input can have significant impacts.

Physical habitat disturbance is also evident in many urban streams. Increased impervious cover in urban areas can result in high flow peaks, which increase bank erosion. In addition, construction and other land-disturbing activities in these areas often provide an excess sediment load, resulting in a smothering of the natural substrate and physical form of streams with banks of sand and silt.

4.2 Summary of Stressors Affecting Water Quality

Section 4.1 described the major sources of loads of pollutants (and other types of stressors) to the Savannah basin. What happens in a river is often the result of the combined impact of many different types of loading, including point and nonpoint sources. For instance, excess concentrations of nutrients may result from the combined loads of wastewater treatment plant discharges, runoff from agriculture, runoff from residential lots, and other sources. Accordingly, Section 4.2 brings together the information contained in Section 4.1 to focus on individual stressor types, as derived from all sources.

4.2.1 Nutrients

All plants require certain nutrients for growth, including the algae and rooted plants found in lakes, rivers, and streams. Nutrients required in the greatest amounts include nitrogen and phosphorus. Some loading of these nutrients is needed to support normal growth of aquatic plants, an important part of the food chain. Too much loading of nutrients can, however, result in an overabundance of algal growth with a variety of undesirable impacts. The condition of excessive nutrient-induced plant production is known as eutrophication, and waters affected by this condition are said to be eutrophic. Eutrophic waters often experience dense blooms of algae, which can lead to unaesthetic scums and odors and interfere with recreation. In addition, overnight respiration of living algae, and decay of dead algae and other plant material, can deplete oxygen from the water, stressing or killing fish. Eutrophication of lakes typically results in a shift in fish populations to less desirable, pollution-tolerant species. Finally, eutrophication may result in blooms of certain species of blue-green algae which have the capability of producing toxins.

For freshwater aquatic systems, the nutrient in the shortest supply relative to plant demands is usually phosphorus. Phosphorus is then said to be the “limiting nutrient” because the concentration of phosphorus limits potential plant growth. Control of nutrient loading to reduce eutrophication thus focuses on phosphorus control.

Point and nonpoint sources to the Savannah also discharge large quantities of nitrogen, but nitrogen is usually present in excess of amounts required to match the available phosphorus. Nitrogen (unlike phosphorus) is also readily available in the atmosphere and ground water, so it is not usually the target of management to control eutrophication in freshwater. The bulk of the nitrogen in fresh-water systems is found in three ionic forms--ammonium (NH_4^+), nitrite (NO_2^-), or nitrate (NO_3^-). Nitrite and nitrate are more readily taken up by most algae, but ammonia is of particular concern because it can be toxic to fish and other aquatic life. Accordingly, wastewater treatment plant upgrades have focused on reducing the toxic ammonia component of nitrogen discharges, with corresponding increase in the nitrate fraction.

Sources of Nutrient Loading

The major sources of nutrient loading in the Savannah basin are wastewater treatment facilities, urban runoff and storm water, and agricultural runoff. Concentrations found within rivers and lakes of the Savannah basin represent a combination of a variety of point and nonpoint source contributions.

Point source loads can be quantified from permit and effluent monitoring data, but nonpoint loads are difficult to quantify. Rough estimates of average nutrient loading rates from agriculture are available; however, nonpoint loads from urban/residential sources in the basin have not yet been quantified. The net load arising from all sources may, however, be examined from instream monitoring. Long-term trends in nutrients within the Savannah River basin can be obtained by examining results from EPD long-term trend monitoring stations.

Trends in instream total phosphorus concentrations at two sites in the Savannah River are shown in Figures 4-23 and 4-24. At the monitoring location at Clyo, approximately 120 miles downstream, phosphorus concentrations have remained relatively similar over time with some slight increase in the late 1980s. At the monitoring station below Spirit Creek downstream of Augusta, phosphorus concentrations can be seen to increase through the mid to late 1980s with a decrease into the 1990s as a result of upgrades at the Augusta Water Pollution Control Plant.

4.2.2 Dissolved Oxygen

Oxygen is required to support aquatic life, and Georgia water quality standards specify minimum and daily average dissolved oxygen concentration standards for all waters. Problems with oxygen depletion in rivers and streams of the Savannah basin are associated with oxygen-demanding wastes from point and nonpoint sources. Historically, the greatest threat to maintaining adequate oxygen levels to support aquatic life has come from the discharge of oxygen-demanding wastes from wastewater treatment plants. Treatment upgrades and more stringent permit limits have reduced this threat substantially.

Deep, hypolimnetic releases from Hartwell and Clarks Hill Dams result in dissolved oxygen concentrations that do not meet state standards downstream in the Savannah River during summer and early fall months. Oxygen deficiencies are most profound in the Hartwell tailwaters, which are designated as trout waters. The turbines at Hartwell Dam are currently being retrofitted with baffles to improve downstream dissolved oxygen levels. The Corps of Engineers will monitor downstream to document resulting changes in dissolved oxygen.

Trends in instream dissolved oxygen concentrations at two sites in the Savannah River basin are shown in Figures 4-25 and 4-26. At both locations, dissolved oxygen concentrations have remained above the minimum concentration of 4.0 mg/l specified in water quality standards.

4.2.3 Metals

The 1998-1999 water quality assessment noted four stream segments where violations of metals standards caused nonsupport of designated uses In most cases, these metals were attributed to point sources. In each situation, the municipality or industry is under an EPD enforcement action to correct the problem.

4.2.4 Fecal Coliform Bacteria

Violations of the standard for fecal coliform bacteria were the most commonly listed cause of nonsupport of designated uses in the 1998-1999 water quality assessment. Fecal coliform bacteria are monitored as an indicator of fecal contamination and the possible presence of human bacterial and protozoan pathogens in water. Fecal coliform bacteria may arise from many of the different point and nonpoint sources discussed in Section 4.1. Human waste is of greatest concern as a potential source of bacteria and other pathogens. One primary function of wastewater treatment plants is to reduce this risk through disinfection.

Trends in instream fecal coliform concentrations at two sites in the Savannah River Basin are shown in Figures 2-27 and 4-28. At both locations fecal coliform densities have decreased over time due primarily to improved treatment at water pollution control plants.

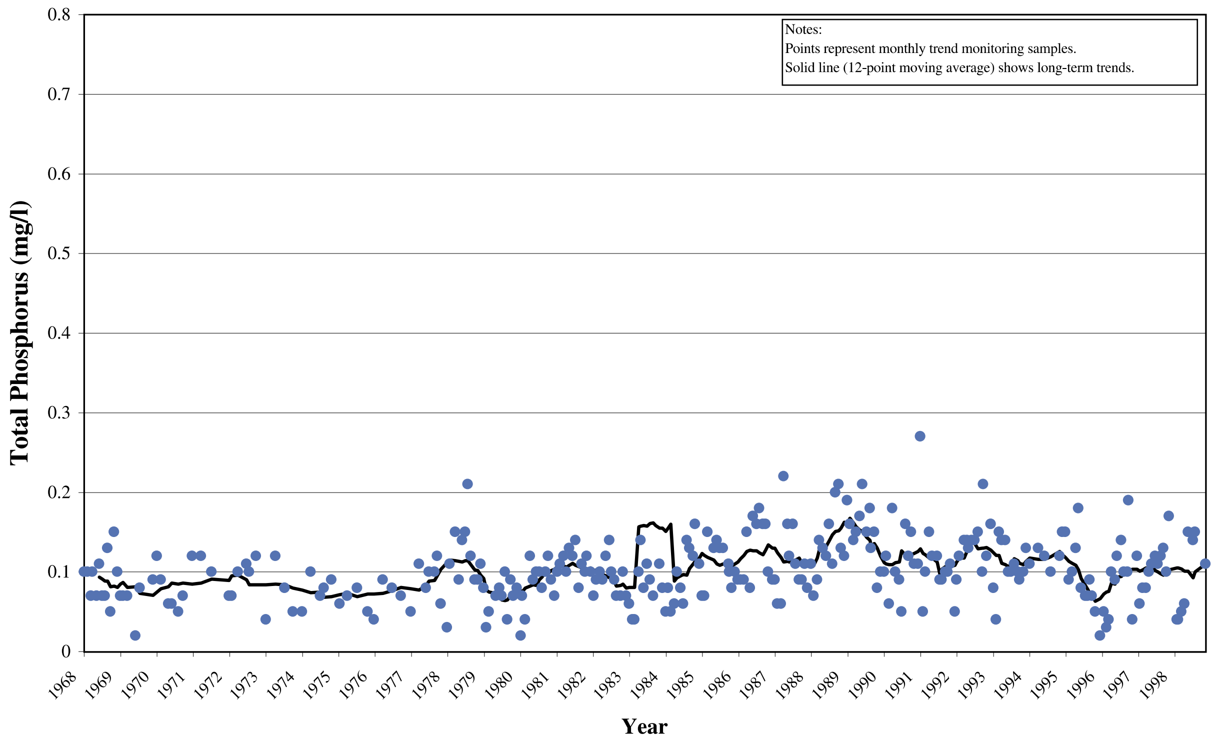

Figure 4-23. Phosphorus Concentrations, Savannah River near Clyo

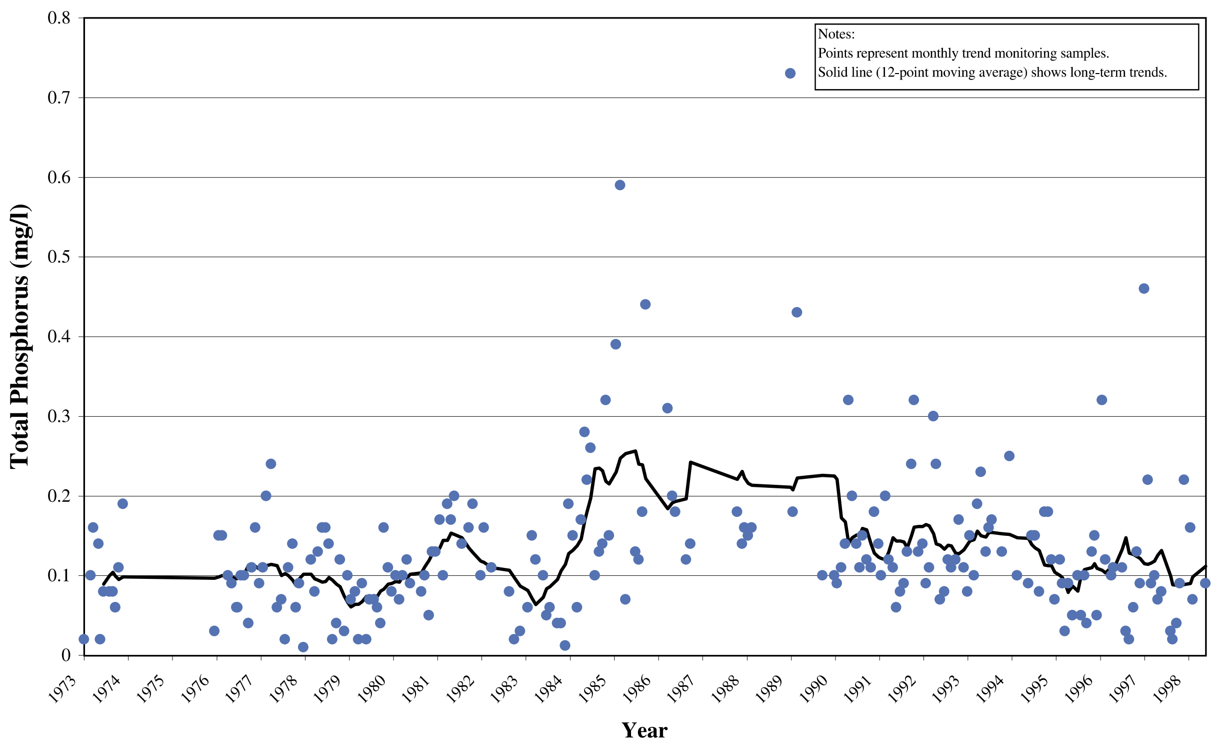

Figure 4-24. Phosphorus Concentrations, Savannah River below Spirit Creek

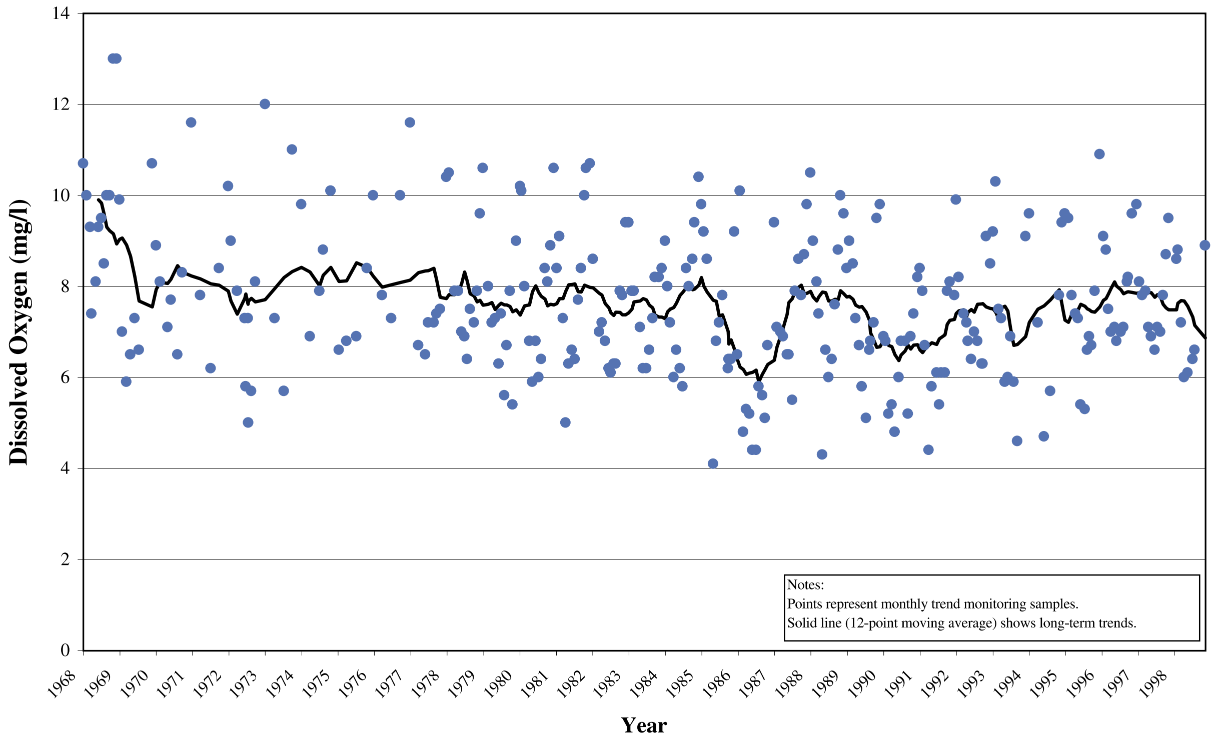

Figure 4-25. Oxygen Concentrations, Savannah River near Clyo

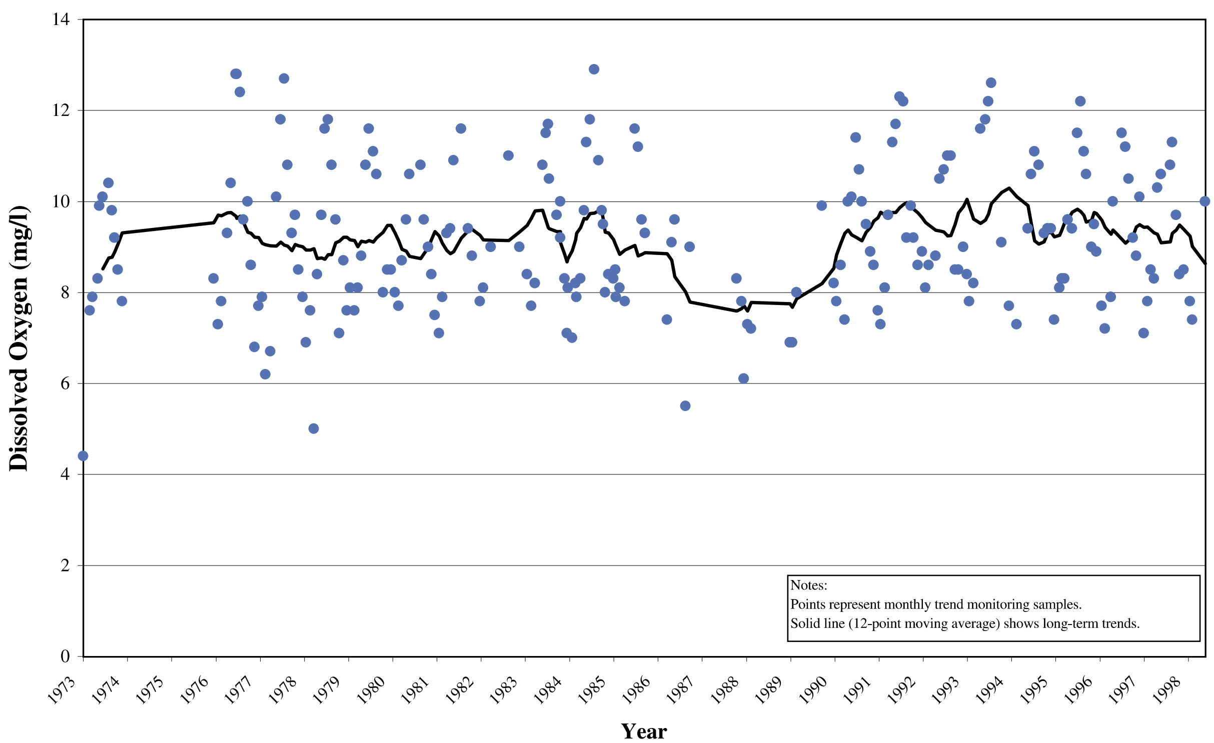

Figure 4-26. Oxygen Concentrations, Savannah River below Spirit Creek

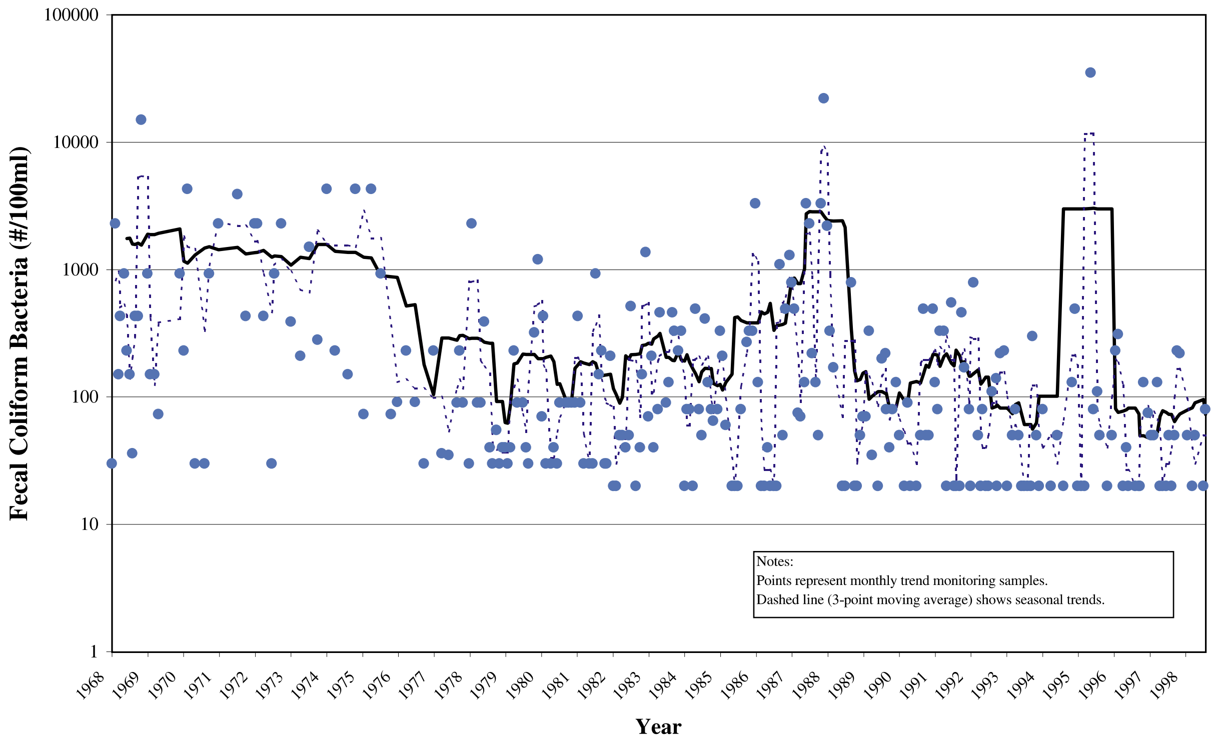

Figure 4-27. Fecal Concentrations, Savannah River near Clyo

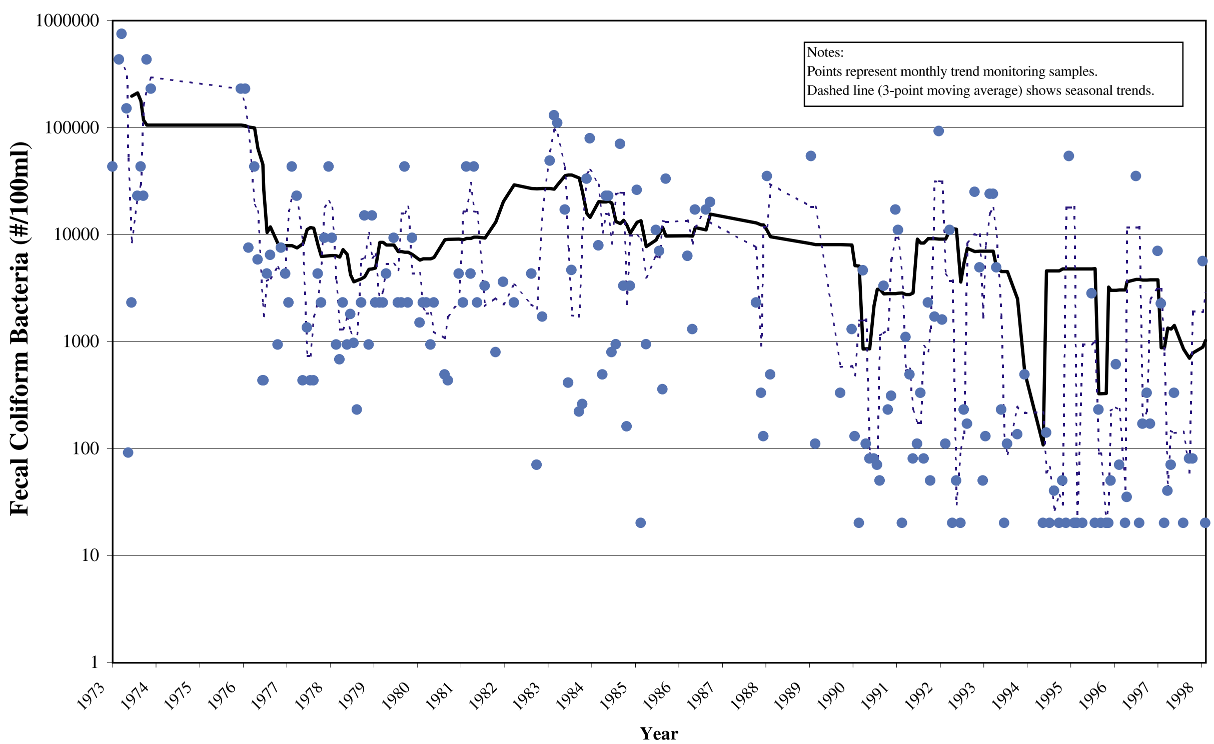

Figure 4-28. Fecal Concentrations, Savannah River below Spirit Creek

As point sources have been brought under control, nonpoint sources have become increasingly important as potential sources of fecal coliform bacteria. Nonpoint sources may include

- Agricultural nonpoint sources, including concentrated animal operations and spreading and/or disposal of animal wastes.
- Runoff from urban areas transporting surface dirt and litter, which may include both human and animal fecal matter, as well as a fecal component derived from sanitary sewer overflows.
- Urban and rural input from failed or ponding septic systems.

4.2.5 Synthetic Organic Chemicals

Synthetic organic chemicals (SOCs) include pesticides, herbicides, and other man-made toxic chemicals. SOCs may be discharged to waterbodies in a variety of ways, including

- Industrial point source discharges.
- Wastewater treatment plant point source discharges, which often include industrial effluent as well as SOCs from household disposal of products such as cleaning agents and insecticides.
- Nonpoint runoff from agricultural and silvicultural land with pesticide and herbicide applications.
- Nonpoint runoff from urban areas, which may load a variety of SOCs such as horticultural chemicals and termiticides.
- Illegal disposal and dumping of wastes.

To date, SOCs have not been detected in the surface waters of the Savannah River basin in problem concentrations. It should be noted, however, that most monitoring has been targeted to waters located below point sources where potential problems were suspected. Agricultural sources were potentially important in the past, particularly from cotton production in the Coastal Plain, but the risk has apparently greatly declined with a switch to less persistent pesticides. Recent research by USGS (Hippe et al., 1994; Stell et al., 1995) suggests pesticide/herbicide loading in urban runoff and storm water may be of greater concern than agricultural loading, particularly in streams of the metropolitan Atlanta area.

4.2.6 Stressors from Flow and Temperature Modification

Stress from flow modification is primarily associated with peaking hydropower operation of dams on the Savannah River, as well as stormflow in smaller streams associated with development and increased impervious area.

4.2.7 Sediment

Erosion, discharge of sediment, and bedload resuspension can have a number of adverse impacts on water quality. First, sediment and bedload resuspension can carry attached nutrients, pesticides, and metals into streams. Second, sediment is itself a stressor. Excess sediment loads and bedload resuspension can alter habitat, destroy spawning substrate, and choke aquatic life, while high turbidity also impairs recreational and drinking water uses. Sediment loading is of concern throughout the basin, but is of greatest concern in the developing metropolitan areas and major transportation corridors. The rural areas are of lesser concern with the exception of rural unpaved road systems and areas where cultivated cropland exceeds 20 percent of the total land cover.

4.2.8 Habitat Degradation and Loss

In many parts of the Savannah basin, support for native aquatic life is potentially threatened by degradation of aquatic habitat. Habitat degradation is closely tied to sediment loading, and excess sediment is the main threat to habitat in rural areas with extensive land-disturbing activities, as well as in urban areas where increased flow peaks and construction can choke and alter stream bottom substrates. A second important type of habitat degradation in the Savannah basin is loss of riparian tree cover, which can lead to increased water temperatures.

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